United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
North Dakota Agricultural
Experiment Station,
North Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of Cavalier County, North Dakota

How To Use This Soil Survey

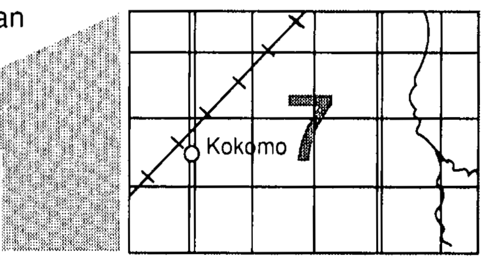
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

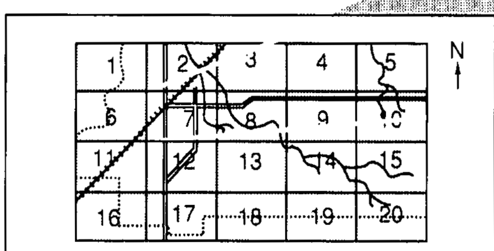
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



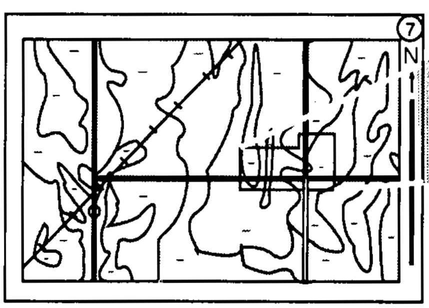
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

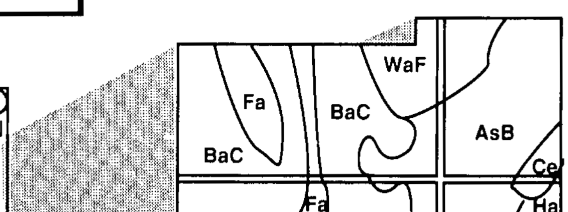


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota Soil Conservation Committee. Financial assistance was provided by the Cavalier County Board of Commissioners and the North Dakota Department of University and School Lands. It is part of the technical assistance furnished to the Cavalier County Soil Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Spring wheat swathed in preparation for combining in an area of Rolette soils on the foot slopes and La Prairie soils on the flood plain. Kloten and Olga soils are in the wooded area in the background.

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Issued May 1990

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Cavalier County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Ronnie L. Clark
State Conservationist
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Soil Survey of Cavalier County, North Dakota

By Melvin Simmons and Dean K. Moos, Soil Conservation Service

Fieldwork by James A. Doolittle, Michael Ulmer, Melvin Simmons, Dean K. Moos, Ricky J. Bigler, Don Moen, Mark Morrison, Cornelius J. Heidt, and Ron Luethe, Soil Conservation Service; Chris Osen, North Dakota State Soil Conservation Committee; and Hal C. Weiser, Francis Wilhelm, and Dave Wroblewski, professional soil classifiers

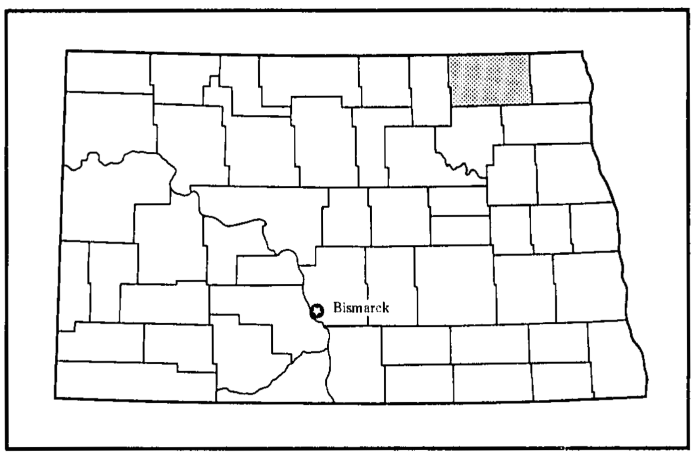
Map finishing by David W. Hickcox and Steven S. Kranich, North Dakota State Soil Conservation Committee

United States Department of Agriculture, Soil Conservation Service
in cooperation with
North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service, and North Dakota State Soil Conservation Committee

CAVALIER COUNTY is in the northeastern part of North Dakota (fig. 1). The county has a total area of 968,320 acres, or 1,513 square miles. Langdon, which is both the county seat and the largest community, is centrally located within the county.

Farming is the main economic enterprise. The principal crops are spring wheat, durum, barley, flax, and sunflowers.

Most of the soils in the county are deep. They are suited to cultivated crops and to pasture and hay. Unfavorable soil characteristics lower the potential of some of the soils for crops. Poor surface drainage in many level and depressional soils is the major concern of management, especially during wet periods. Soil blowing is a hazard on nearly all of the soils. It is most severe on the sandy soils on delta plains. About 186,000 acres of the soils in the county are saline or alkali.



Location of Cavalier County in North Dakota.

General Nature of the County

This section provides general information about the survey area. It discusses climate, history and development, water supply, transportation, and physiography, relief, and drainage.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Cavalier County is usually quite warm in summer. It

is characterized by frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the area. Most precipitation falls during the warm period and is normally heaviest late in spring and early in summer. Winter snowfall usually is not too heavy, and it is blown into drifts so that much of the ground is left free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Langdon in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 5 degrees F and the average daily minimum temperature is -5 degrees. The lowest temperature on record, which occurred at Langdon on January 28, 1966, is -45 degrees. In summer, the average temperature is 64 degrees and the average daily maximum temperature is 78 degrees. The highest recorded temperature, which occurred at Langdon on July 29, 1975, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 19 inches. Of this, 15 inches, or about 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 4.2 inches at Langdon on August 31, 1979. Thunderstorms occur on about 33 days each year.

The average seasonal snowfall is about 37 inches. The greatest snow depth at any one time during the period of record was 33 inches. On the average, 77 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

Several times each winter, storms accompanied by snow and high wind bring blizzard conditions to the area. Hail during summer thunderstorms occurs in small, scattered areas.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the North. Average windspeed is highest, 14 miles per hour, in spring.

History and Development

In the early days the area that was to become Cavalier County was a favorite resort of buffalo hunters, especially the Metis, who roamed the area between White Horse Plains and Devils Lake. The area along the Pembina River provided the wood and water necessary for survival of the hunters, and the nearby plains to the west nourished the large herds of buffalo.

The history of permanent white settlement in the area began with the filing of the first homestead in the state of North Dakota by Joe Rolette on parts of sec. 4, T. 163 N., R. 57 W., in what is now Cavalier County, on June 15, 1868.

In 1873 Cavalier County was established from parts of Pembina County. It was first spelled "Cavileer" and named for Charles Cavileer, the first white settler in North Dakota. After the first settlement of the town of Cavalier in Pembina County, however, the spelling of the name of the county was also changed to Cavalier.

Squatters began settling in the eastern part of the county as early as 1879; others followed in 1880 and 1881. The early settlers were primarily farmers, or "sod busters," who tilled the thick black prairie soil with the recently developed steel plow. They depended on the railroad to bring them manufactured goods and to carry to market the surpluses of their fields.

The first post office was established at Olga in 1885, and the first store in the county was started near Olga at Beaulier.

In 1883 Patrick McHugh and W.J. Mooney, coming to the area from Grafton, settled on the land where Langdon now stands and commenced the organization of Cavalier County. Cavalier County was then officially organized on July 8, 1884. On August 26, 1884, Langdon was officially named the county seat in honor of R.B. Langdon of Minnesota, a famous railroad builder and politician.

The years between 1865 and 1889 were a period of rapid growth and often violent changes. These were hard times. Crops froze repeatedly, and some families literally starved. However, Langdon, Milton, Osnabrock, and Olga were boom towns, growing so fast that visitors were astounded at the changes each time they entered one of the towns.

In 1889 North Dakota became a state and prohibition became the law in Cavalier County; this put many people out of work and gave rise to much stricter law enforcement. Many people simply vanished from the

county or disappeared into obscurity. Because the railroad brought many new settlers, the population doubled between 1907 and 1930.

Since World War II there has been a steady decline in the population and in the number of family farms in Cavalier County. The average size of the family farm has increased since 1945. The population of Cavalier County is about 7,636. Langdon, with a population of about 2,335, is the county seat and the largest community.

Cavalier County has always been a leading grain producing area. As early as 1890, Cavalier County was shipping more than 1,000,000 bushels of wheat a year to market, and since 1910 Cavalier County had led the state. Today, Cavalier County ranks in the top five counties in North Dakota in the production of barley, durum, and spring wheat *(10)*.

Water Supply

The major sources of water in Cavalier County are the aquifers, lakes, rivers, and individual wells. Water supply for the city of Langdon is obtained from the Mount Carmel Dam, about 12 miles northeast of town.

The Pierre aquifer underlies most of Cavalier County. Wells in this aquifer yield small to moderate amounts of water that is fresh to moderately saline. The water is used for domestic and livestock purposes throughout Cavalier County.

The Icelandic and Pembina Delta aquifers are mainly in the northeastern part of Cavalier County. The maximum well yield that can be expected from these aquifers is about 50 gallons per minute. The water quality is among the best in the county.

The Munich aquifer is the most productive aquifer in Cavalier County. It underlies about 30 square miles of southwestern Cavalier County, near the city of Munich. The average thickness of the aquifer is about 40 feet, but locally the aquifer may reach 200 feet. The aquifer, which contains about 1.1 million acre-feet of water in storage, supplies many domestic and livestock wells. It is a potential source of water supply for the city of Munich. Properly constructed wells should be capable of yielding as much as 500 gallons per minute. Water from the Munich aquifer is predominantly very hard, is slightly saline, and is a sodium sulfate type with a high concentration of iron *(8)*.

Transportation

North Dakota Highway 1 and county highway 20 are the major north-south routes in the county. North Dakota Highway 5 and county highways 66 and 55 are the major east-west routes. These highways and the paved and gravelled county and township roads provide a good network of roadways. The county is also served by two railroads *(7)*.

Physiography, Relief, and Drainage

Nearly all of Cavalier County lies within the physiographic district of the Drift Prairie. The Drift Prairie is gently rolling to undulating and is underlain by sediment deposited by glaciers (fig. 2). Elevation in the county ranges from 1,620 feet in the western part to less than 1,200 feet in the northeastern part. Drainage is poorly developed, and streams that are poorly developed generally flow in channels that formerly carried water from the melting glaciers. The Pembina Escarpment, along the eastern edge of Cavalier County, marks the eastern edge of the Drift Prairie. To the east of this escarpment is the Red River Valley. Cavalier County is on the eastern edge of the Williston Basin *(7)*.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge

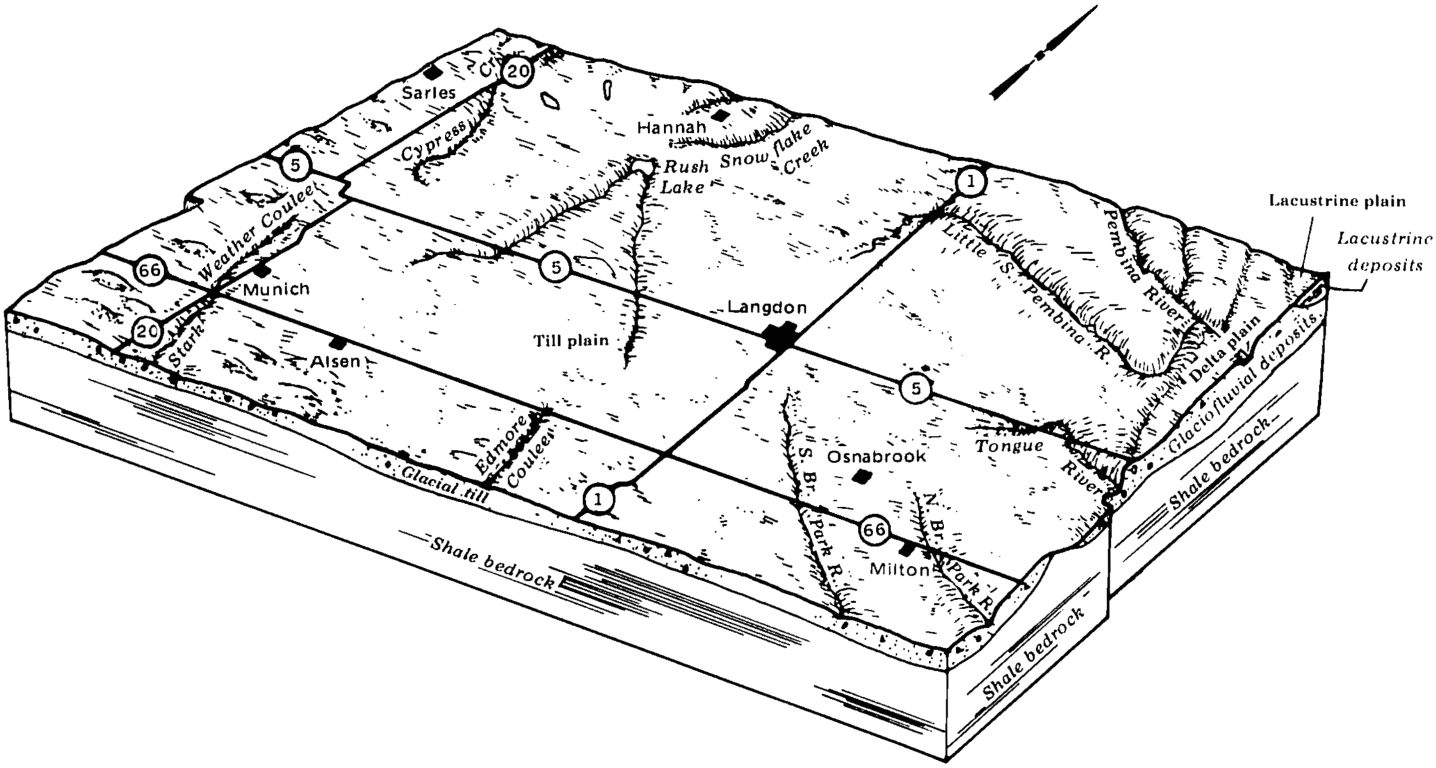


Figure 2.—Physiographic features of Cavalier County.

into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

The section "Survey Procedures" explains specific procedures used to make this survey.

Survey Procedures

The general procedures used to make this survey are described in the *National Soils Handbook* and the *Soil Survey Manual (15)*. *Geology of Cavalier and Pembina Counties (3)* and *Soil Taxonomy (17)*, *Land Resource Regions and Major Land Resource Areas of the United States (18)*, and *Major Soils of North Dakota (13)* and the *County General Soil Maps (14)* were among the references used.

Procedures for determining the nature and characteristics of the soil can be found in the section "How This Survey was Made."

Traverses were made on foot, by pickup, or by all-terrain vehicles at an interval close enough to locate contrasting soil areas of 3 to 5 acres. All map units were characterized by transecting representative units. At least one transect was recorded for each 1,000 acres of the units mapped. Data collected from the transects were used to justify names and establish the range of composition of each map unit.

Each soil map unit has a minimum documentation of two pedon descriptions for each soil series used in its name.

The composition of each map unit is given in the detailed map unit descriptions. Composition was calculated from data collected through point intercept transects. These were made by traversing representative delineations of each map unit and determining the kind of soil at set intervals. Two to ten transects were made on each map unit.

The confidence interval (range of composition) given in the map unit description was determined from transect data through the use of the method described by R.G. Cline *(6)*. This method was used to determine

the confidence interval of the mean at the 90 percent probability level. In other words, there is a 90 percent probability that the true average composition of the map unit in the county lies within the range listed in the text. Expressing composition in these terms should give the user a more realistic idea of the distribution of soils in the map units because it stresses the fact that the composition of a map unit differs between delineations and that soil variability prevents us from knowing with complete certainty what the composition of the units is.

Laboratory samples were collected in 1982 and 1983 for all pedons. Analyses were made by the North Dakota State Highway Department. Analysis data from representative pedons are given in table 17. These pedons were also analyzed for engineering properties by the North Dakota State University Soil Characterization Laboratory.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries on the general soil map in this soil survey do not fully match those on the general soil map of Pembina and Walsh Counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly in modification or refinement in soil series concepts. Also, there are differences in the intensity of mapping and the extent of the soils within the survey area.

Soil Descriptions

Level and Nearly Level, Clayey, Silty, and Loamy Soils

These soils formed in glaciolacustrine deposits, glacial till, and alluvium. They make up about 4 percent of the county. Most areas are used for cultivated crops, hay, and wetland wildlife habitat. The soils are suited to cultivated crops and are well suited to range, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and overcoming wetness. The main concern in managing hay is maintaining an adequate cover of the adapted native or introduced forage plants. The main concerns in managing wetland wildlife habitat areas are maintaining the natural wetness and controlling siltation.

1. Hegne-Glyndon Association

Deep, level, poorly drained and somewhat poorly drained, fine textured and medium textured soils

This association is on flats and low rises on lacustrine plains. Surface drains remove excess water from most areas. Slope is 0 to 1 percent.

This association makes up about 1 percent of the county. It is about 60 percent Hegne soils, 10 percent Glyndon and similar soils, and 30 percent soils of minor extent.

The poorly drained, highly calcareous Hegne soils are on the flats. Typically, the surface soil is black silty clay about 11 inches thick. The subsoil is silty clay about 25 inches thick. It is dark gray in the upper part and gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay.

The somewhat poorly drained, highly calcareous Glyndon soils are on the low rises. Typically, the surface soil is about 15 inches thick. It is black. It is silt loam in the upper part and very fine sandy loam in the lower part. The subsoil is grayish brown, mottled very fine sandy loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loamy very fine sand.

Binford, Cashel, and Divide are the principal minor soils in this association. The somewhat excessively drained Binford soils are on flats and ridges, and the somewhat poorly drained Divide soils are on flats. Both soils have a sand and gravel substratum. The somewhat poorly drained Cashel soils are on flood plains. They have a buried surface layer.

Most areas are used for cultivated crops. A few small areas of the saline Hegne soils are used for pasture or hay. The association is suited to these uses. Controlling

soil blowing and overcoming wetness and salinity are the main concerns in managing cultivated areas. Maintaining an adequate cover of the adapted, introduced forage plants is the main concern in managing hay or pasture.

2. Vallers-Southam-Hamerly Association

Deep, level and nearly level, very poorly drained to somewhat poorly drained, medium textured, moderately fine textured, and fine textured soils

This association is in depressions and drainageways and on flats and rises on till plains. The landscape is dotted with knobs and knolls and with areas of water. Slope ranges from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 35 percent Vallers soils, 33 percent Southam soils, 10 percent Hamerly soils, and 22 percent soils of minor extent.

The level, poorly drained, highly calcareous, saline Vallers soils are on the flats and in the drainageways. Typically, the surface soil is black loam or silty clay loam about 11 inches thick. It contains masses of salt and gypsum. The subsoil is about 12 inches thick. It is very dark gray loam in the upper part and light olive gray, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is light brownish gray in the upper part and grayish brown in the lower part.

The level, very poorly drained Southam soils are in the depressions. Typically, the surface soil is about 53 inches thick. It is black clay in the upper part; black, mottled silty clay in the next part; and very dark gray, mottled clay in the lower part. The substratum to a depth of about 60 inches is dark olive gray, mottled clay.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats and rises. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

Buse, Cresbard, and Svea are the principal minor soils in this association. The well drained Buse soils are on knobs and ridges. The moderately well drained Cresbard soils have a dense, alkali subsoil. Areas of Cresbard soils are intermingled with areas of the Hamerly soils. The moderately well drained Svea soils are on flats.

Most areas are used for cultivated crops, hay, or wetland wildlife habitat. The association is poorly suited to cultivated crops and is well suited to hay and range. The Southam soils are best suited to wetland wildlife habitat. Controlling soil blowing and overcoming wetness and salinity are the main concerns in managing cultivated areas. Maintaining an adequate cover of the adapted, introduced or native forage plants is the principal concern in managing range or hay. Maintaining the natural wetness and controlling siltation are the principal concerns in managing wetland wildlife habitat.

Level to Rolling, Loamy and Silty Soils

These soils formed in glacial till, alluvium, and glaciofluvial deposits. They make up about 87 percent of the county. Most areas are used for cultivated crops. The soils are suited to cultivated crops and are well suited to range, pasture, and hay. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing hay, range, and pasture areas is maintaining an adequate cover of the adapted, introduced or native forage plants.

3. Svea-Hamerly-Buse Association

Deep, level to rolling, well drained to somewhat poorly drained, medium textured soils

This association is on knolls, ridges, and flats and in swales on till plains. Slopes are short and irregular. The landscape is dotted with depressions. Slope ranges from 0 to 15 percent.

This association makes up about 11 percent of the county. It is about 39 percent Svea and similar soils, 27 percent Hamerly and similar soils, 17 percent Buse soils, and 17 percent soils of minor extent (fig. 3).

The level to rolling, well drained and moderately well drained Svea soils are on the flats and in the swales. Typically, the surface soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats and in the swales. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is

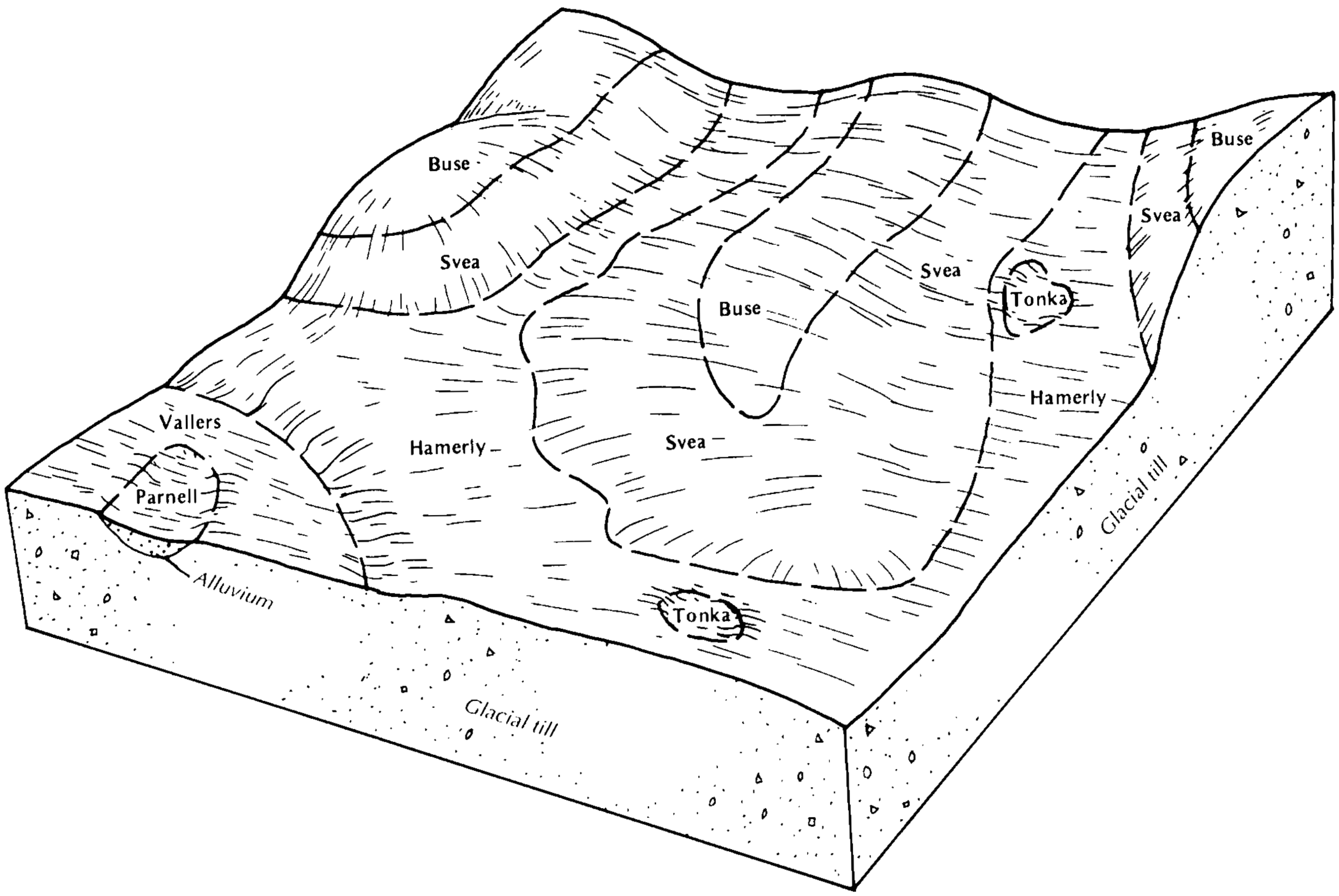


Figure 3.—Typical pattern of soils and parent material in the Svea-Hamerly-Buse association.

light olive brown, mottled clay loam.

The undulating to rolling, well drained Buse soils are on the knolls and ridges. Typically, the surface layer is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam.

Parnell, Tonka, and Vallers are the principal minor soils in this association. The very poorly drained Parnell soils and poorly drained Tonka soils have an accumulation of clay in the subsoil. They are in depressions. The poorly drained Vallers soils have a light brownish gray and grayish brown substratum. They are on flats adjacent to depressions.

Most areas are used for cultivated crops. The association is suited to this use and to range, pasture, and hay. Controlling soil blowing and water erosion is the main concern in managing cultivated areas.

4. Hamerly-Svea-Tonka Association

Deep, level and nearly level, moderately well drained to poorly drained, medium textured soils

This association is on flats and rises and in depressions and swales on till plains. Slopes are short and irregular. The landscape is dotted with knolls and ridges. Slope ranges from 0 to 3 percent.

This association makes up about 36 percent of the county. It is about 42 percent Hamerly and similar soils, 13 percent Svea soils, 12 percent Tonka soils, and 33 percent soils of minor extent.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats and rises. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The

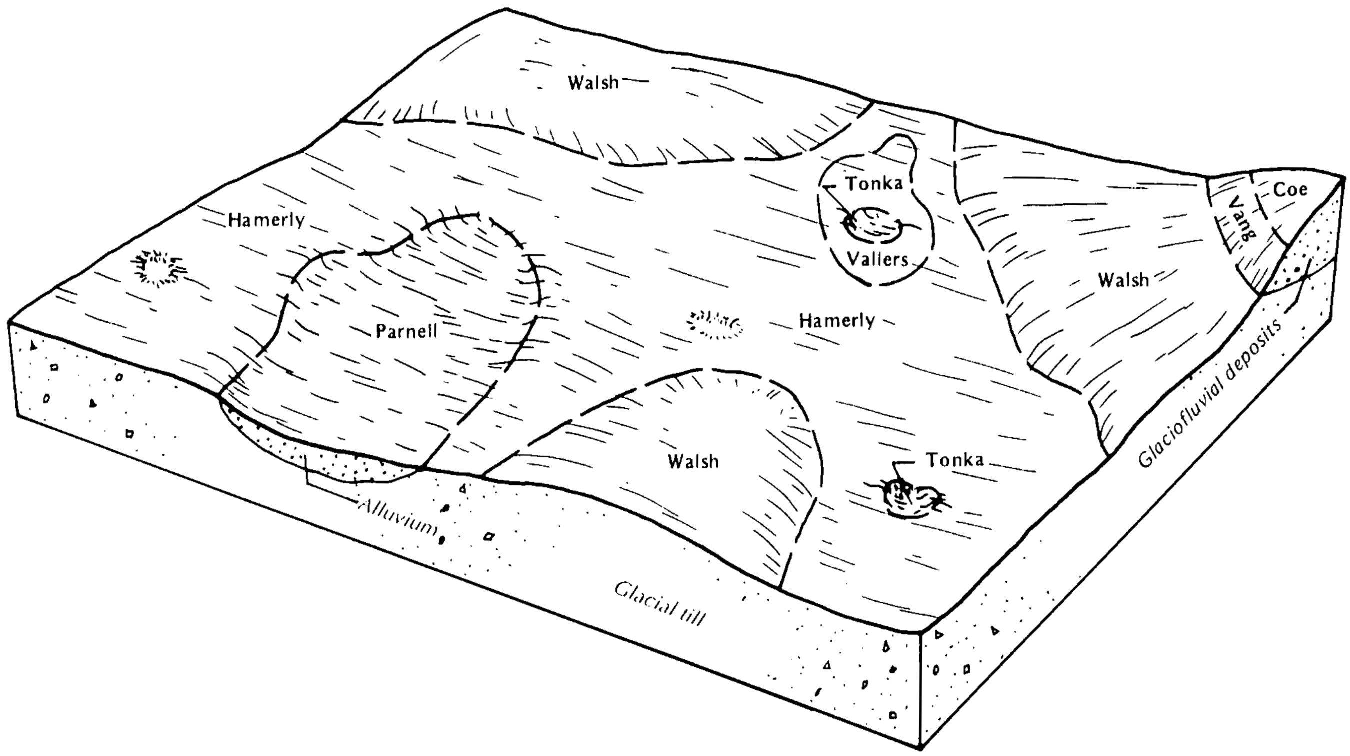


Figure 4.—Typical pattern of soils and parent material in the Hamerly-Walsh-Parnell association.

substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The level and nearly level, moderately well drained Svea soils are on the flats and in the swales. Typically, the surface soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part.

The level, poorly drained Tonka soils are in the depressions. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark gray, mottled loam about 6 inches thick. The subsoil is about 38 inches thick. It is very dark grayish brown, mottled silty clay loam in the upper part; dark grayish brown, mottled silty clay loam in the next part; and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam.

Buse, Cresbard, Parnell, and Vallers are the principal minor soils in this association. The well drained Buse soils are on knolls and ridges. The moderately well drained Cresbard soils have a dense, alkali subsoil. Areas of Cresbard soils are intermingled with areas of the Svea and Hamerly soils. The very poorly drained Parnell soils are in deep depressions. They have an accumulation of clay in the subsoil. The poorly drained Vallers soils have a light brownish gray and grayish brown subsoil. They are on flats adjacent to depressions.

Most areas are used for cultivated crops. The association is suited to this use and to range, hay, and pasture. Controlling soil blowing and water erosion and overcoming wetness in the Tonka soils are the main concerns in managing cultivated areas.

5. Hamerly-Walsh-Parnell Association

Deep, level to undulating, somewhat poorly drained, well drained, and very poorly drained, medium textured soils

This association is on low flats and in depressions and swales on water-smoothed till plains. Slopes are long and smooth. The landscape is dotted with ridges. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the

county. It is about 37 percent Hamerly soils, 18 percent Walsh soils, 7 percent Parnell soils, and 38 percent soils of minor extent (fig. 4).

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats and rises. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The level to undulating, well drained Walsh soils are on the flats and in the swales. Typically, the surface soil is black loam about 11 inches thick. The subsoil is loam about 24 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown loam.

The level, very poorly drained Parnell soils are in the depressions. Typically, the surface has a 1-inch cover of stems, leaves, and roots. The surface soil is black silt loam about 24 inches thick. The subsoil is about 19 inches thick. It is black silty clay loam in the upper part and very dark gray, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam.

Coe, Cresbard, Tonka, Vallers, and Vang are the principal minor soils in this association. The Coe and Vang soils have a gravelly substratum. The excessively drained Coe soils are on ridges and knolls. The well drained Vang soils are on rises. The moderately well drained Cresbard soils have a dense, alkali subsoil. Areas of the Cresbard soils are intermingled with areas of the Hamerly soils. The poorly drained Tonka soils are in shallow depressions. They have an accumulation of clay in the subsoil. The poorly drained Vallers soils have a light brownish gray and grayish brown substratum. They are on flats adjacent to depressions.

Most areas are used for cultivated crops. Some areas are used for wetland wildlife habitat or hay. The association is suited to cultivated crops and to pasture, range, and hay. The Parnell soils are well suited to wetland wildlife habitat. Controlling soil blowing and water erosion and overcoming wetness in the Parnell soils are the main concerns in managing cultivated areas. Maintaining an adequate cover of the adapted, introduced or native forage plants is the main concern in managing hay, pasture, and range. Maintaining the natural water level and controlling siltation are the main concerns in managing areas used for wetland wildlife habitat.

6. Svea-Hamerly-Tonka Association

Deep, level to undulating, moderately well drained to poorly drained, medium textured soils

This association is on flats and in depressions and swales on till plains. Slopes are long and smooth. The landscape is dotted with knolls. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 33 percent Svea soils, 30 percent Hamerly soils, 15 percent Tonka and similar soils, and 22 percent soils of minor extent.

The level to undulating, moderately well drained Svea soils are on the flats and in the swales. Typically, the surface soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The level, poorly drained Tonka soils are in the depressions. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark gray, mottled loam about 6 inches thick. The subsoil is about 38 inches thick. It is very dark grayish brown, mottled silty clay loam in the upper part; dark grayish brown, mottled silty clay loam in the next part; and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam.

Buse, Cresbard, and Parnell are the principal minor soils in this association. The well drained Buse soils are on knolls. The moderately well drained Cresbard soils have a dense, alkali subsoil. Areas of the Cresbard soils are intermingled with areas of the Svea and Hamerly soils. The very poorly drained Parnell soils are in depressions. They have an accumulation of clay in the subsoil.

Most areas are used for cultivated crops. The association is suited to this use and to range, hay, and pasture. Controlling soil blowing and water erosion and overcoming wetness in the Tonka soils are the main concerns in managing cultivated areas.

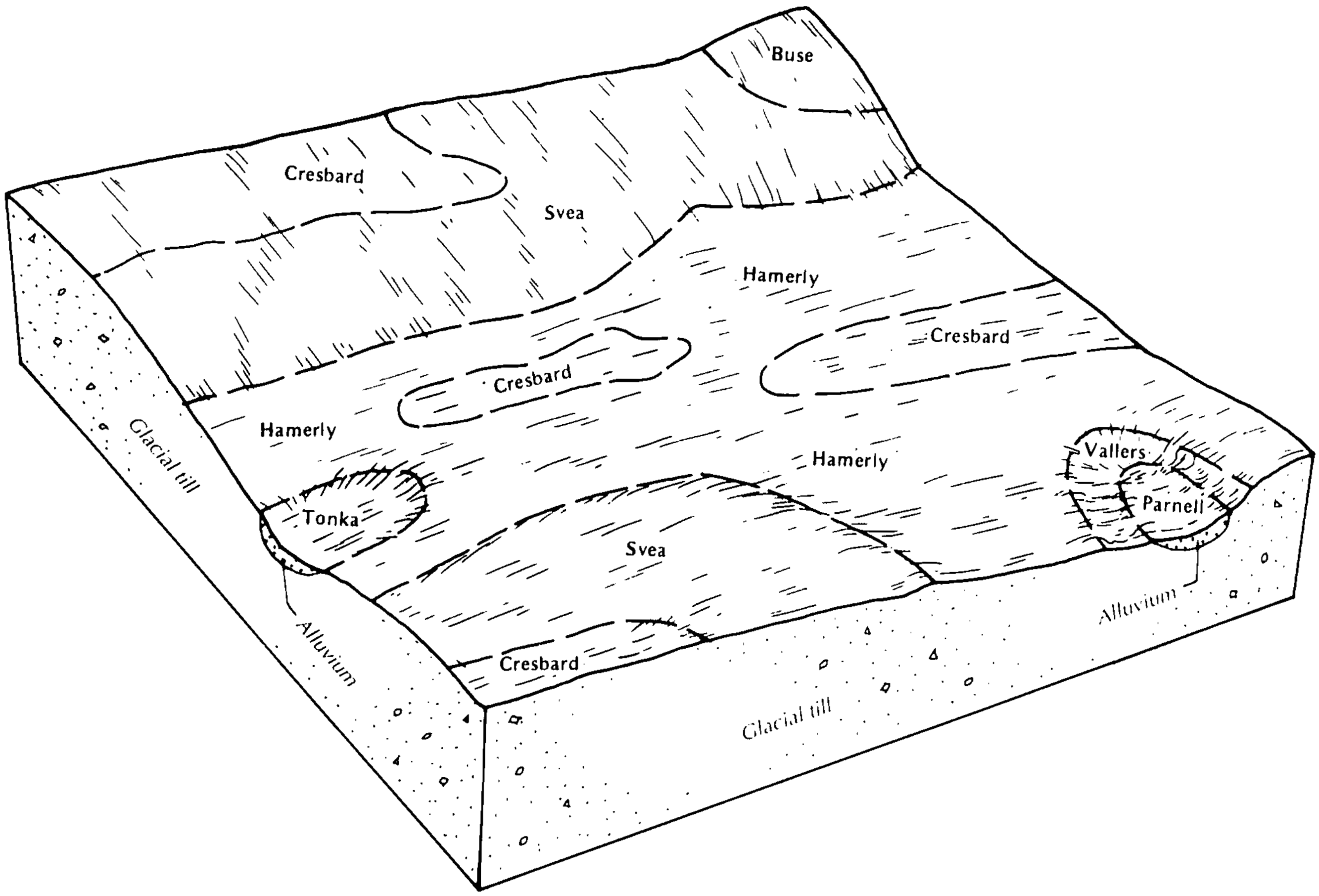


Figure 5.—Typical pattern of soils and parent material in the Svea-Hamerly-Cresbard association.

7. Svea-Hamerly-Cresbard Association

Deep, level to undulating, moderately well drained and somewhat poorly drained, medium textured soils

This association is on rises and flats of till plains. Slopes are long and smooth. The landscape is dotted with depressions and knolls. Slope ranges from 0 to 6 percent.

This association makes up about 27 percent of the county. It is about 22 percent Svea soils, 21 percent Hamerly soils, 20 percent Cresbard soils, and 37 percent soils of minor extent (fig. 5).

The level to undulating, moderately well drained Svea soils are on the rises and flats. Typically, the surface soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part.

The level and nearly level, somewhat poorly drained, highly calcareous Hamerly soils are on the flats. Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

The nearly level and undulating, moderately well drained, alkali Cresbard soils are on the flats and rises. Typically, the surface layer is black loam about 8 inches thick. The next layer is very dark gray clay loam about 1 inch thick. The subsoil is about 28 inches thick. In sequence downward, it is black clay loam, very dark grayish brown clay loam, grayish brown silt loam, and grayish brown loam. The substratum to a depth of about

60 inches is dark grayish brown, mottled loam.

Buse, Parnell, Tonka, and Vallers are the principal minor soils in this association. The well drained Buse soils are on knolls. The very poorly drained Parnell soils and the poorly drained Tonka soils are in depressions. They have an accumulation of clay in the subsoil. The poorly drained Vallers soils are on flats adjacent to depressions. They have a light brownish gray and grayish brown substratum.

Most areas are used for cultivated crops. The association is suited to this use and to range, hay, and pasture. Controlling soil blowing and water erosion and maintaining tilth are the main concerns in managing cultivated areas.

8. Cresbard-Cavour-Svea Association

Deep, level to undulating, moderately well drained, medium textured, dominantly alkali soils

This association is on rises and flats and in swales on till plains. Slopes are long and smooth. The landscape is dotted with depressions. Slope ranges from 0 to 6 percent.

This association makes up about 4 percent of the county. It is about 32 percent Cresbard soils, 21 percent Cavour soils, 19 percent Svea soils, and 28 percent soils of minor extent.

The level to undulating, alkali Cresbard soils are on the flats and rises. Typically, the surface layer is black loam about 8 inches thick. The next layer is very dark gray clay loam about 1 inch thick. The subsoil is about 28 inches thick. In sequence downward, it is black clay loam, very dark grayish brown clay loam, grayish brown silt loam, and grayish brown loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam.

The level and nearly level, alkali Cavour soils are in the swales. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 33 inches thick. It is very dark gray and very dark grayish brown clay in the upper part, dark grayish brown clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

The level to undulating Svea soils are on the rises and flats. Typically, the surface soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part.

Hamerly, Parnell, Tonka, and Vallers are the principal minor soils in this association. The somewhat poorly drained Hamerly soils and poorly drained Vallers soils are on flats surrounding or adjacent to depressions. They are highly calcareous. The very poorly drained Parnell soils and poorly drained Tonka soils are in depressions. They have an accumulation of clay in the subsoil.

Most areas are used for cultivated crops. The association is suited to this use and to hay, range, and pasture. Controlling water erosion and maintaining tilth are the main concerns in managing cultivated areas.

9. Vang-Brantford-Walsh Association

Deep, level to gently rolling, well drained, medium textured soils

This association is on flats and in swales on outwash plains and delta plains. The landscape is dotted with knolls and ridges. Slope ranges from 0 to 9 percent.

This association makes up about 1 percent of the county. It is about 28 percent Vang soils, 26 percent Brantford soils, 15 percent Walsh soils, and 31 percent soils of minor extent.

The level to gently rolling Vang soils are on the flats and rises. Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown. It is clay loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly sand.

The level and nearly level Brantford soils are on the flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly coarse sand in the upper part, dark grayish brown gravelly coarse sand in the next part, and very dark grayish brown very gravelly coarse sand in the lower part.

The level to gently sloping Walsh soils are in the swales and on the flats. Typically, the surface soil is black loam about 11 inches thick. The subsoil is loam about 34 inches thick. It is very dark grayish brown loam in the upper part, dark grayish brown loam in the next part, and dark grayish brown gravelly loam in the lower part. The substratum to a depth of about 60 inches is olive brown gravelly loam.

Coe, Inkster, and Rolette are the principal minor soils in this association. The excessively drained Coe soils

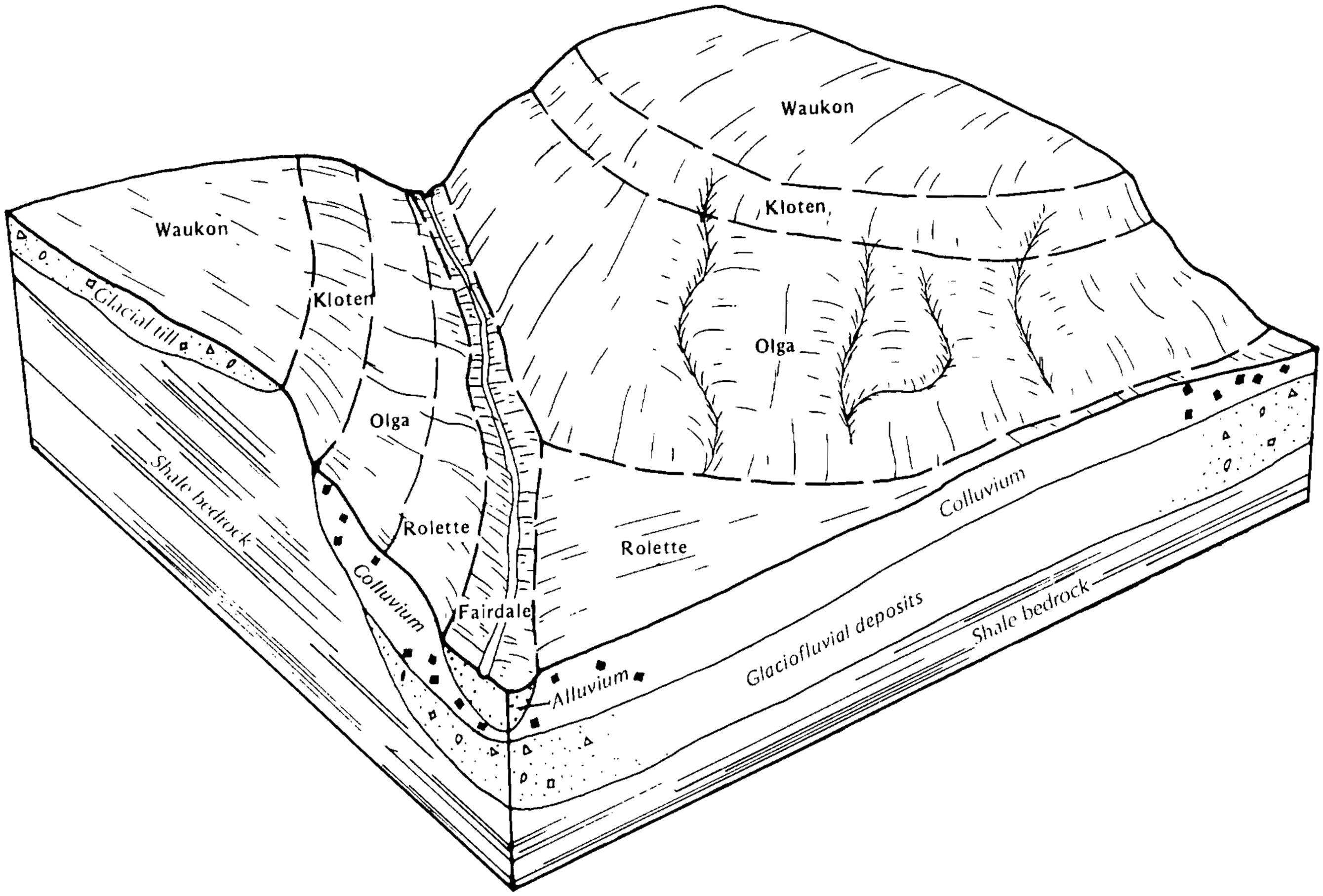


Figure 6.—Typical pattern of soils and parent material in the Olga-Waukon-Rolette association.

are on knolls and ridges. They have a gravelly substratum within about 7 inches of the surface. The Inkster soils have a fine sandy loam subsoil and a sandy loam and loamy sand substratum. They are on flats and rises. The Rolette soils have an accumulation of clay in the subsoil. They are on foot slopes below steep escarpments.

Most areas are used for cultivated crops. The soils are suited to this use and to range, hay, and pasture. Controlling water erosion and overcoming droughtiness in the Vang and Brantford soils are the main concerns in managing cultivated areas.

Level to Very Steep, Silty and Loamy Soils

These soils formed in glacial till, colluvium, and materials weathered from shale. They make up about 8 percent of the county. Most areas are used for cultivated crops, woodland pasture, and range. The soils are best suited to range, woodland pasture, and wildlife habitat. The main concerns in managing cultivated areas are controlling water erosion and maintaining or improving tilth. The main concern in managing woodland pasture or range is maintaining an adequate cover of the native forage plants.

10. Olga-Waukon-Rolette Association

Deep, level to steep, well drained and moderately well drained, moderately fine textured and medium textured soils

This association is on side slopes, foot slopes, and flats on till plains and mantled delta plains. Deep drainageways have dissected the till plain. Slope ranges from 0 to 35 percent.

This association makes up about 7 percent of the county. It is about 26 percent Olga soils, 24 percent Waukon soils, 13 percent Rolette soils, and 37 percent soils of minor extent (fig. 6).

The strongly sloping to steep, well drained Olga soils are on the side slopes. Typically, the surface has a 1-inch cover of partially decomposed leaves, grass, and roots. The surface layer is black silty clay loam about 7 inches thick. The subsurface layer is dark gray silty clay loam about 5 inches thick. The subsoil is silty clay about 18 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 50 inches is dark gray channery silty clay. Below this is soft shale.

The level to moderately sloping, well drained Waukon soils are on the flats and side slopes. Typically, the surface has a 1-inch cover of partially decomposed leaves, twigs, and roots. The surface layer is black loam about 3 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The next layer is very dark grayish brown loam about 4 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam.

The nearly level to moderately sloping, moderately well drained Rolette soils are on the foot slopes. Typically, the surface layer is black clay loam about 8 inches thick. The next layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 37 inches thick. It is very dark grayish brown silty clay in the upper part and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam.

Cresbard, Fairdale, Hattie, Kelvin, and Kloten are the principal minor soils in this association. The moderately well drained Cresbard soils are in swales. They have a dense, alkali subsoil. The moderately well drained Fairdale soils are on flood plains. They have a substratum that is stratified in the upper part. The moderately well drained Hattie soils are on flats. They have a clay surface layer and subsoil. The well drained Kelvin soils are on flats and rises. They have a loam surface layer and a clay loam subsoil. The well drained Kloten soils are on shoulder slopes. They are shallow.

Most areas are used as woodland wildlife habitat or woodland pasture. Some areas, particularly areas of the Waukon and Rolette soils, are used for cultivated crops. Maintaining an adequate cover of the native woody and forage plants is the main concern in managing pasture and wildlife habitat areas. Controlling water erosion and maintaining or improving tilth are the main concerns in managing cultivated areas.

11. Kloten-Buse-Walsh Association

Shallow and deep, moderately sloping to very steep, well drained, medium textured soils

This association is on shoulder slopes, side slopes, and foot slopes on dissected till plains. Shale is exposed on some cutbanks and slump areas. Slope ranges from 6 to 120 percent.

This association makes up about 1 percent of the county. It is about 30 percent Kloten soils, 26 percent Buse soils, 19 percent Walsh soils, and 25 percent soils of minor extent (fig. 7).

The moderately sloping to very steep, shallow Kloten soils are on the side slopes. Typically, the surface layer is very dark gray loam about 7 inches thick. The substratum to a depth of about 14 inches is very dark grayish brown channery loam. Below this is shale.

The moderately steep and steep, deep Buse soils are on the shoulder slopes. Typically, the surface layer is black loam about 9 inches thick. The subsoil is grayish brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam.

The moderately sloping and strongly sloping, deep Walsh soils are on the foot slopes. Typically, the surface layer is black loam about 11 inches thick. The subsoil is loam about 24 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown loam.

Fairdale, Lamoure, and Svea are the principal minor soils in this association. The moderately well drained Fairdale soils and poorly drained Lamoure soils are on flood plains. The Fairdale soils have a substratum that is stratified in the upper part. The Lamoure soils have a thick silt loam surface soil and a loam substratum. The well drained Svea soils are on foot slopes and in swales. They are loam throughout.

Most areas are used as range or wildlife habitat. Some areas, particularly areas of the Walsh soils, are used for cultivated crops. The association is suited to these uses. Maintaining an adequate cover of the native forage plants and achieving uniform distribution of grazing are the main concerns in managing range. Controlling water erosion on the Walsh soils is the main concern in managing cultivated areas.

Level to Steep, Sandy and Loamy Soils

These soils formed in glaciofluvial deposits on delta plains. They make up about 1 percent of the county.

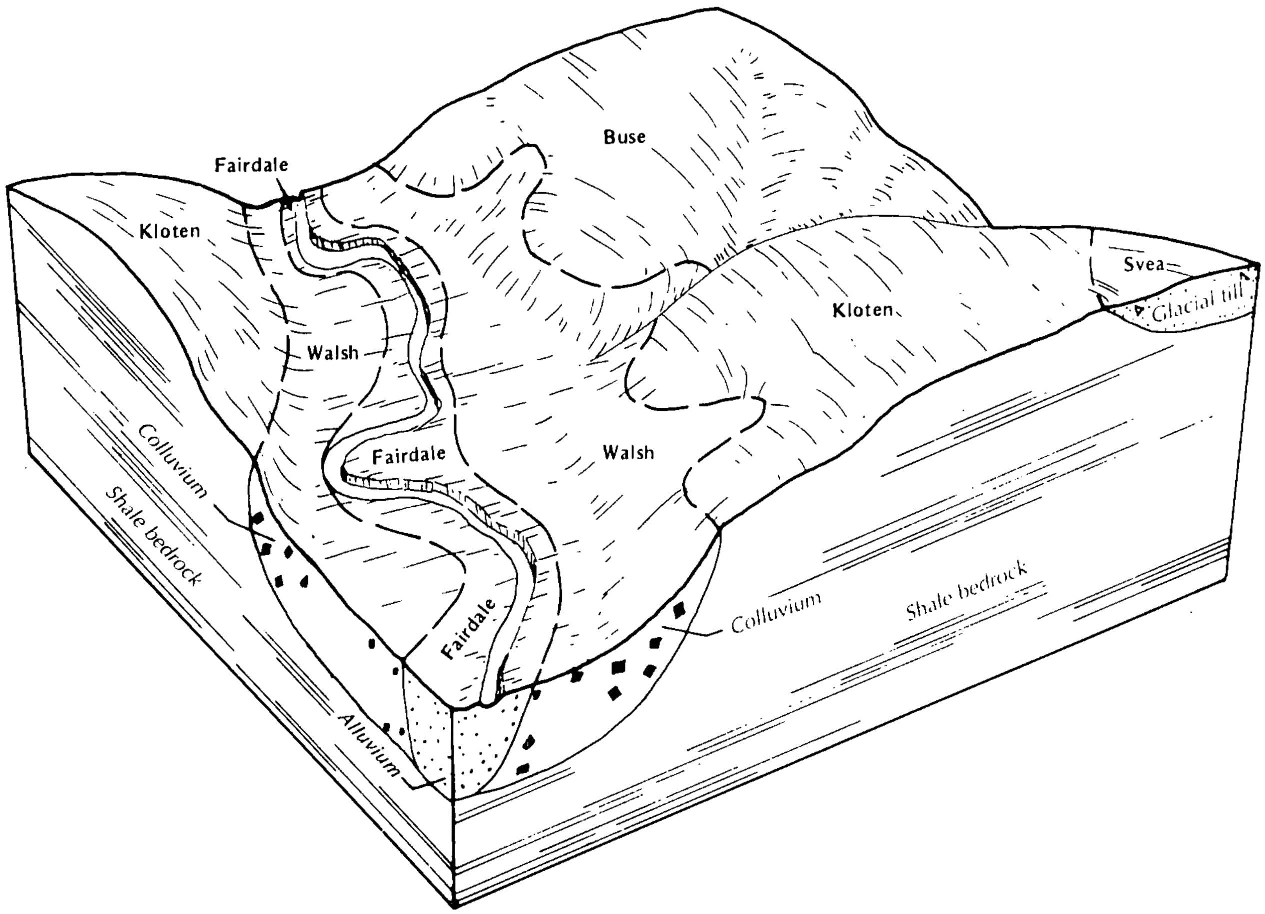


Figure 7.—Typical pattern of soils and parent material in the Kloten-Buse-Walsh association.

Most areas are used for cultivated crops. The soils are suited to cultivated crops, pasture, and hay. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

12. Maddock-Arveson-Binford Association

Deep, level to steep, well drained, poorly drained, and somewhat excessively drained, coarse textured, medium textured, and moderately coarse textured soils

This association is on flats, ridges, knolls, and side slopes and in swales on delta plains. The landscape is dotted with depressions and is dissected by deep, entrenched drainageways. Slope ranges from 0 to 35 percent.

This association makes up about 1 percent of the county. It is about 48 percent Maddock and similar soils, 13 percent Arveson and similar soils, 12 percent Binford soils, and 27 percent soils of minor extent.

The nearly level to steep, well drained Maddock soils are on the knolls and side slopes. Typically, the surface layer is very dark gray loamy fine sand about 8 inches thick. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark brown loamy fine sand in the upper part, dark brown fine sand in the next part, and grayish brown fine sand in the lower part.

The level, poorly drained, highly calcareous Arveson soils are on the flats and in the swales. Typically, the surface layer is black loam about 8 inches thick. The next layer is dark gray, mottled fine sandy loam about 5 inches thick. The subsoil is grayish brown, mottled fine sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled fine sandy loam in the upper part and light brownish gray, mottled loamy sand in the lower part.

The nearly level to moderately sloping, somewhat excessively drained Binford soils are on the ridges and

flats. Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is very dark grayish brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is dark grayish brown gravelly sand in the upper part, grayish brown gravelly coarse sand in the next part, and gray sand in the lower part.

Hamar and Inkster are the principal minor soils in this association. The poorly drained Hamar soils are in depressions. They have a loamy fine sand surface layer and a loamy fine sand and fine sand substratum. The well drained Inkster soils are in swales. They have a loam surface layer, a fine sandy loam subsoil, and a sandy loam and loamy sand substratum.

Most areas are used for cultivated crops. Some areas, particularly areas of the steeper Maddock soils, are used as pasture or wildlife habitat. Controlling soil blowing and overcoming droughtiness are the main concerns in managing cultivated areas. Maintaining an adequate cover of the adapted introduced forage plants is the main concern in managing pasture areas.

Broad Land Use Considerations

In 1987 about 82 percent of the land in Cavalier County was used for cultivated crops. The rest was used for pasture and hay, recreation, woodland, and wildlife habitat. The general soil map in this soil survey is a useful tool for those who make broad land use decisions in Cavalier County.

The soils in Cavalier County generally are suited to cultivated crops. Wetness and salinity are the major concerns if the Vallers-Southam-Hamerly and Hegne-Glyndon associations are cultivated. The dense, alkali subsoil of the Cresbard and Cavour soils in the Cresbard-Cavour-Svea association restricts the depth to which plant roots can penetrate. Droughtiness and soil blowing are the main concerns if the Vang-Brantford-Walsh and Maddock-Arveson-Binford associations are cultivated. Slope and depth to bedrock are the limitations that most affect use of the Olga-Waukon-Rolette and Kloten-Buse-Walsh associations for cultivated crops.

Pasture or hay production is the second most extensive land use in Cavalier County. Most of the soils have good potential for this use, but cropland is the preferred use. The soil limitations that affect cropland also tend to affect pastureland and hayland, but generally to a lesser extent. Ponding on the Southam soils in the Vallers-Southam-Hamerly association generally limits their use to wetland wildlife habitat. Soils in the Kloten-Buse-Walsh association are used as pasture because of their steepness of slope.

Cavalier County has several thousand acres of woodland. The soils in the Olga-Waukon-Rolette association are used mainly as woodland because of their steepness of slope.

Most of the soils in Cavalier County are suited to urban uses. Because of the declining population, the acreage of soils used for urban development also is declining. Because of slow permeability and a seasonal high water table, the soils in the Cresbard-Cavour-Svea association generally are unsuited to septic tank absorption fields. Because of rapid permeability and the possibility of ground water pollution, most of the soils in the Brantford-Vang-Walsh and Maddock-Binford-Arveson associations are poorly suited to septic tank absorption fields. Steepness of slope, slow absorption of liquid wastes, and shallow depth to bedrock limit use of the soils in the Kloten-Buse-Walsh and Olga-Waukon-Rolette associations for urban development. Because of the wetness and ponding, the soils in the Vallers-Southam-Hamerly and Hegne-Glyndon associations are not suited to urban development.

Recreational development is not extensive in Cavalier County. Areas where the soils have good potential for recreational use are throughout the county; however, cultivated crop production is the preferred use in these areas.

Wetland wildlife habitat in Cavalier County is important, particularly to migratory waterfowl. The Southam soils in the Vallers-Southam-Hamerly association and the Parnell soils in the Hamerly-Walsh-Parnell association provide much of the wetland wildlife habitat in the county. The other soil associations in the county have good or fair potential for one or more types of wildlife habitat.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Hegne silty clay, saline, is a phase of the Hegne series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Vallers, saline-Parnell complex is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries on the detailed soil map in this soil survey do not fully match those on the detailed soil maps of Pembina and Walsh Counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinement in soil series concepts. Also, there are differences in the intensity of mapping and the extent of the soils within the survey area.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1—Southam clay. This deep, level, very poorly drained soil is in deep depressions on till plains. It is subject to ponding. Individual areas range from about 5 acres to more than 100 acres in size.

Typically, the surface soil is about 53 inches thick. It is black clay in the upper part; black, mottled silty clay in the next part; and very dark gray, mottled clay in the lower part. The substratum to a depth of about 60 inches is dark olive gray, mottled clay. In some places the soil has a noncalcareous subsoil. In other places the soil is silty clay loam throughout.

Figure 8.—An area of Southam clay that provides food and cover for wetland wildlife.

Included with this soil in mapping are small areas of the poorly drained Tonka and Vallers soils. These soils make up 5 to 15 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer more than 4 inches thick. They are in the shallow part of depressions and on the rims of deep depressions. Vallers soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on rims of the depressions.

Permeability is slow in the Southam soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 5 feet above to 1 foot below the surface. The organic matter content is very high.

Most areas of this soil are used for wetland wildlife habitat (fig. 8). The soil generally is unsuited to small grain, sunflowers, flax, trees, shrubs, pasture, and hay. It is best suited to wetland wildlife habitat. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and water level and controlling siltation.

This soil generally is unsuited to septic tank absorption fields and buildings because of the ponding. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

2—Vallers, saline-Parnell complex. These deep, level soils are on till plains. The poorly drained, highly calcareous, saline Vallers soil is on flats surrounding depressions. The very poorly drained Parnell soil is in the depressions. It is subject to ponding. Individual areas range from about 5 acres to more than 300 acres in size. They are about 40 to 55 percent Vallers soil and 40 to 55 percent Parnell soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Vallers soil is black loam about 11 inches thick. It contains masses of salt and gypsum. The subsoil is about 12 inches thick. It is very dark gray loam in the upper part and light olive gray, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is light brownish gray in the upper part and grayish brown in the lower part. In some places the soil is strongly saline. In other places it does not have a layer of lime accumulation within 16 inches of the surface. In a few areas the surface layer is clay loam.

Typically, about 1 inch of stems, leaves, and roots is at the surface of the Parnell soil. The surface soil is black silt loam about 24 inches thick. The subsoil is about 19 inches thick. It is black silty clay loam in the upper part and very dark gray, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In some places the soil does not have a subsoil. In other places it has a subsoil that has an accumulation of lime.

Included with these soils in mapping are small areas of the poorly drained Tonka soils and somewhat poorly drained Hamerly soils. These included soils make up about 5 to 20 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer. They are in the shallower part of the depressions. Hamerly soils are olive brown in the lower part of the substratum. They are on flats.

Permeability is moderately slow in the Vallers soil and slow in the Parnell soil. Runoff is slow on the Vallers soil and ponded on the Parnell soil. Available water capacity is moderate in the Vallers soil and high in the Parnell soil. Salts in the Vallers soil reduce the amount of water available to plants. A seasonal high water table is within a depth of 1 foot of the surface in the Vallers soil and is 2 feet above to 2 feet below the surface of the Parnell soil. Tilth is fair in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for hay, pasture, cultivated crops, or wetland wildlife habitat. The soils are poorly suited to small grain, sunflowers, and flax. They are best suited to salt-tolerant crops. They also are suited to hay and pasture. The hazard of soil blowing is moderate on the Vallers soil and slight on the Parnell soil. The hazard of water erosion is slight on both soils.

Overcoming wetness and salinity and controlling soil blowing are the main management concerns if cultivated crops are grown. A surface drainage system helps to reduce the wetness, but adequate outlets commonly are not available. The degree of salinity is greater in some drained areas. If no drainage system is installed, crops are planted and harvested in only 2 to 4 years out of 10 on the Parnell soil and only 6 to 8 years out of 10 on the Vallers soil. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

These soils are suited to wetland wildlife habitat. The Parnell soil and the ponded water provide habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and water level and controlling siltation.

The important native forage plants on these soils are slim sedge, slough sedge, and rivergrass. Tall wheatgrass, western wheatgrass, and sweetclover are suitable pasture and hay plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soils are wet. They can be overcome by deferring grazing when the soils are wet.

If drained, the Parnell soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. In undrained areas, however, it generally is unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The Vallers soil is suited to only a few of the most salt-tolerant, climatically adapted species. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields and buildings because of the wetness, the slow permeability, and the ponding. Better sites generally are nearby.

The land capability classification of the Vallers soil is IIIs, and that of the Parnell soil is IIIw. The productivity index of the unit for spring wheat is 35 to 60, depending on the degree of drainage and salinity. The range site of the Vallers soil is Saline Lowland, and that of the Parnell soil is Wetland.

3—Parnell silt loam. This deep, level, very poorly drained soil is in deep depressions on till plains. It is subject to ponding. Individual areas range from about 4 acres to more than 50 acres in size.

Typically, about 1 inch of stems, leaves, and roots is at the surface. The surface soil is black silt loam about 24 inches thick. The subsoil is about 19 inches thick. It is black silty clay loam in the upper part and very dark gray, mottled silty clay in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In some places the soil does not have a subsoil. In other places it has a subsoil that has an accumulation of lime.

Included with this soil in mapping are small areas of the poorly drained Tonka and Vallers soils. These soils make up about 5 to 15 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer more than 4 inches thick. They are in the shallower part of depressions. Vallers soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on the rim of depressions.

Permeability is slow in the Parnell soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 2 feet above to 2 feet below the surface. Tilth is good. The organic matter content is high.

Most areas of this soil are used for native hay or wetland wildlife habitat; however, some areas are drained and used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. It is best suited to hay or wetland wildlife habitat. The hazards of soil blowing and water erosion are slight. Overcoming wetness is the main management concern if cultivated crops are grown. Wetness can be overcome by constructing a surface drainage system and delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control erosion and provides food and cover for resident and migratory wildlife. Where the soil is undrained, crops are planted and harvested in only 2 to 4 years out of 10. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and water level and controlling sedimentation.

The important native forage plants are slough sedge and rivergrass. Compaction, trampling, and root shearing are problems, especially if the range is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 20 to 75, depending on the degree of drainage. The range site is Wetland.

4—Easby clay loam. This deep, level, poorly drained, highly calcareous, strongly saline soil is on flats and in drainageways on till plains. Individual areas range from about 5 acres to more than 100 acres in size.

Typically, the surface layer is black clay loam about 7 inches thick. It contains masses of salt. The next layer is dark gray clay loam about 4 inches thick. The subsoil is light brownish gray, mottled clay loam about 11 inches thick. It contains masses of gypsum. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam in the upper part; grayish brown, mottled loam in the next part; and olive brown, mottled loam in the lower part. In some places the soil is only slightly saline or moderately saline. In other places the surface layer is loam. In a few areas the soil does not have a layer of lime accumulation within 16 inches of the surface.

Included with this soil in mapping are small areas of the very poorly drained Parnell soils, poorly drained Tonka soils, and somewhat poorly drained Hamerly soils. These soils make up about 5 to 15 percent of the individual mapped areas. Parnell and Tonka soils have an accumulation of clay in the subsoil. Both soils are in depressions. Hamerly soils are olive brown in the lower part of the substratum. They are on rises.

Permeability is moderately slow in the Easby soil. Runoff is very slow. Available water capacity is low. The salts in the soil reduce the amount of water available to plants. A seasonal high water table is at a depth of 0 to 1 foot. The organic matter content is high.

Most areas of this soil are used for range or wetland wildlife habitat. Because of the salinity and wetness, the soil generally is unsuited to small grain, sunflowers, flax, pasture, and trees and shrubs. It is best suited to range. The hazard of soil blowing is moderate, and that of water erosion is slight. The important native forage plants are western wheatgrass, Nuttall alkaligrass, and inland saltgrass. Soil blowing is a hazard, especially if

the range is overgrazed. It can be overcome by maintaining an adequate cover of the important forage plants.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the slow permeability. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland.

5—Manfred-Vallers, saline, silty clay loams. These deep, level, poorly drained soils are on till plains. The alkali, moderately saline Manfred soil is in shallow depressions. It is subject to ponding. The highly calcareous, moderately saline Vallers soil is on flats surrounding the depressions. Individual areas range from 5 acres to more than 200 acres in size. They are 50 to 65 percent Manfred soil and 30 to 50 percent Vallers soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Manfred soil is black silty clay loam about 7 inches thick. The subsoil is mottled silty clay loam about 23 inches thick. It is black in the upper part and light olive gray in the lower part. The upper part of the substratum is olive gray, mottled clay loam. The lower part to a depth of about 60 inches is light olive brown, mottled gravelly clay loam. In some places the soil is strongly saline. In other places it has a light colored subsurface layer and a nonalkali subsoil. In a few areas the subsoil is silty clay.

Typically, the surface layer of the Vallers soil is black silty clay loam about 11 inches thick. It contains masses of salt and gypsum. The subsoil is about 12 inches thick. It is very dark gray loam in the upper part and light olive gray, mottled silty clay loam in the lower part. It contains masses of salt and gypsum. The mottled substratum to a depth of about 60 inches is clay loam. It is light brownish gray in the upper part and grayish brown in the lower part. In some places the soil is strongly saline.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly and Miranda soils and moderately well drained Cavour soils. These included soils make up about 5 to 10 percent of the individual mapped areas. Hamerly soils are olive brown in the lower part of the substratum. Miranda and Cavour soils do not have a mottled subsoil. They are on rises.

Permeability is slow in the Manfred soil and moderately slow in the Vallers soil. Runoff is ponded on the Manfred soil and slow on the Vallers soil. Available water capacity is high in the Manfred soil and moderate in the Vallers soil. Salts in both soils reduce the amount of water available to plants. The dense, alkali subsoil of the Manfred soil restricts root penetration. A seasonal high water table is 1 foot above to 1 foot below the surface of the Manfred soil and within a depth of 1 foot in the Vallers soil. Tilth is poor in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for hay, pasture, cultivated crops, or wetland wildlife habitat. The soils are unsuited to small grain, sunflowers, and flax. They are best suited to hay and pasture and to wetland wildlife habitat. The Manfred soil and the ponded water provide habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and water level and controlling siltation.

The important native forage plants on these soils are slim sedge, slough sedge, and rivergrass. Tall wheatgrass, western wheatgrass, and sweetclover are suitable pasture and hay plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soils are wet. They can be overcome by deferring grazing when the soils are wet.

The Vallers soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Manfred soil generally is unsuited to trees and shrubs. Individual trees and shrubs vary in height, density, and vigor. They are affected by the reduced amount of available water, which is caused by the salts in the soil. Reducing the evaporation at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to septic tank absorption fields and buildings because of the wetness, the slow permeability, and the ponding. Better sites generally are nearby.

The land capability classification of the Manfred soil is VIs, and that of the Vallers soil is IIIs. The productivity index of the unit for spring wheat is 0. The range site of both soils is Saline Lowland.

6—La Prairie loam. This deep, level, moderately well drained soil is on flats on flood plains. It is subject to occasional flooding. Individual areas range from about 5 acres to more than 30 acres in size.

Typically, the surface soil is black loam about 18 inches thick. The subsoil is loam about 13 inches thick.

It is very dark gray in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown. It is loam in the upper part and fine sandy loam in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the surface soil is silty clay loam or silt loam. In a few areas the soil does not have a subsoil.

Included with this soil in mapping are small areas of the moderately well drained Fairdale soils. These soils make up 5 to 15 percent of the individual mapped areas. Fairdale soils have a dark colored surface layer that is less than 8 inches thick and have fine stratification below the surface layer. They are in swales.

Permeability is moderate in the La Prairie soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 3.5 to 6.0 feet. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. A few small areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Maintaining tilth is the main management concern if cultivated crops are grown. Seeding may be delayed in some years as a result of flooding. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control erosion and maintain tilth. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the flooding. Better sites generally are nearby.

The land capability classification is IIc. The productivity index for spring wheat is 95.

7—Fairdale loam, channeled. This deep, level, moderately well drained soil is on flats on flood plains. It is subject to occasional flooding. Most areas are dissected by meandering channels. Most tillable areas are narrow and linear or small and isolated by deep channels or steep escarpments. Individual areas range from about 5 acres to more than 300 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown, stratified fine sandy loam and loam. It is mottled between depths of 54 and 60 inches. In some places the surface layer is fine sandy loam. In other places the dark color of the surface soil extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of very poorly drained soils in oxbows and meanders and excessively drained soils that are very shallow over gravel and are on low terraces and point bars. These soils make up 5 to 10 percent of the individual mapped areas.

Permeability is moderate in the Fairdale soil. Runoff is slow. Available water capacity is high. The organic matter content is high.

Most areas of this soil are used for range and wildlife habitat. A few small isolated areas are used for cultivated crops. Because the steep-sided channels generally cannot be crossed by machinery and because tillable areas are dissected and small, this soil generally is unsuited to cultivated crops and hay.

The important native forage plants are big bluestem and green needlegrass. Scouring as a result of flooding is a hazard, especially if the range is overgrazed. It can be controlled by maintaining an adequate cover of the important forage plants.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The meandering channels make the use of machinery difficult. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the flooding. Better sites generally are nearby.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Overflow.

8—Lamoure silt loam. This deep, level, poorly drained soil is on flats on flood plains. It is subject to occasional flooding. Some areas are dissected by meandering channels. Individual areas range from 10 acres to more than 100 acres in size.

Typically, the surface soil is about 38 inches thick. It is silt loam. It is black in the upper part and very dark gray in the lower part. It is mottled between depths of 7 and 38 inches. The substratum to a depth of about 60 inches is dark olive gray, mottled loam. In some places the soil is saline. In other places the surface layer and substratum are loam. In a few areas the soil has a subsoil that has an accumulation of lime. In the eastern

part of the county, lime is absent throughout the profile.

Included with this soil in mapping are small areas of a very poorly drained soil along drainageways and moderately well drained La Prairie soils on rises. These soils make up about 5 to 15 percent of the individual mapped areas. La Prairie soils have a subsoil.

Permeability is moderate in the Lamoure soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 0 to 2 feet. Tilth is good.

Most areas of this soil are used for pasture, hay, or wildlife habitat. A few areas are used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. It is best suited to hay, pasture, and wildlife habitat. The hazard of soil blowing is moderate, and that of water erosion is slight. Overcoming wetness and flooding and controlling soil blowing are the main management concerns if cultivated crops are grown. A surface drainage system helps to reduce the wetness; however, the degree of salinity is greater in some drained areas. Seeding may be delayed in some years as a result of flooding. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important native forage plants are big bluestem and switchgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Scouring as a result of flooding is a hazard, especially if the range or pasture is overgrazed. It can be controlled by maintaining an adequate cover of the important or suitable forage plants. Compaction, trampling, and root shearing also are problems, especially if the range or pasture is grazed when the soil is wet. They can be overcome by deferring grazing when the soil is wet.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the flooding. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 40 to 60, depending on the degree of drainage.

10—Svea-Barnes loams, 0 to 3 percent slopes. These deep, level and nearly level soils are on till plains. The moderately well drained Svea soil is in swales and on flats. The well drained Barnes soil is on rises. Individual areas range from about 5 acres to more than 200 acres in size. They are about 50 to 75 percent Svea soil and 20 to 35 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. In some places the surface soil is clay loam. In other places the substratum contains shale fragments.

Typically, the surface layer of the Barnes soil is black loam about 8 inches thick. The subsoil is loam about 18 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In places the surface layer is clay loam.

Included with these soils in mapping are small areas of the poorly drained Tonka soils, somewhat poorly drained Hamerly soils, moderately well drained Cresbard soils, and well drained Buse soils. These included soils make up 5 to 20 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer. They are in shallow depressions. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats adjacent to depressions. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Svea soil. Buse soils have a calcareous subsoil. They are on ridges and knolls.

Permeability is moderately slow in the Svea and Barnes soils. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazards of water erosion and soil blowing are slight. Maintaining tilth is the main management

concern if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface helps to maintain or improve tilth and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material help to maintain tilth.

The Svea soil is suited to all and the Barnes soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The shrink-swell potential of both soils is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements in the Svea soil.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 90.

10B—Svea-Barnes loams, 3 to 6 percent slopes. These deep, undulating soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Barnes soil is on rises. Individual areas range from 5 acres to more than 100 acres in size. They are 40 to 55 percent Svea soil and 30 to 45 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. In places the surface soil is clay loam.

Typically, the surface layer of the Barnes soil is black loam about 8 inches thick. The subsoil is loam about 18 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam.

Included with these soils in mapping are small areas of the poorly drained Tonka soils, somewhat poorly drained Hamerly soils, moderately well drained Cresbard soils, and well drained Buse soils. These included soils make up 5 to 20 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer. They are in shallow depressions. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats adjacent to depressions. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Svea soil. Buse soils have a calcareous subsoil. They are on ridges and knolls.

Permeability is moderately slow in the Svea and Barnes soils. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Maintaining tilth and controlling water erosion are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface and installing grassed waterways in areas where runoff concentrates help to maintain tilth and control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

The Svea soil is suited to all and the Barnes soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The shrink-swell potential of both soils is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent

structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements in the Svea soil.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 85.

11B—Svea-Buse loams, 3 to 6 percent slopes. These deep, undulating soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Buse soil is on knolls. Individual areas range from 5 acres to more than 400 acres in size. They are 50 to 65 percent Svea soil and 30 to 40 percent Buse soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the surface soil is clay loam.

Typically, the surface layer of the Buse soil is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the surface layer and substratum are sandy loam. In other places the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Included with these soils in mapping are small areas of the poorly drained Tonka soils, somewhat poorly drained Hamerly soils, moderately well drained Cresbard soils, and excessively drained Coe and Sioux soils. These included soils make up 5 to 15 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer. They are in shallow depressions. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats adjacent to depressions. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Svea soils. Coe and Sioux soils have a gravelly substratum. They are on knobs.

Permeability is moderately slow in the Svea and Buse soils. Runoff is medium. Available water capacity is high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils. The organic matter content is high in the Svea soil and moderately low in the Buse soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate on both soils. The hazard of soil blowing is slight on the Svea soil and moderate on the Buse soil. Maintaining tilth and controlling erosion are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, providing annual buffer strips, and installing grassed waterways in areas where runoff concentrates help to maintain tilth and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

The Svea soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Buse soil is suited to only the most drought-tolerant, climatically adapted species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The seasonal high water table in the Svea soil is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The shrink-swell potential of both soils is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The drainage also helps to prevent seepage into basements in the Svea soil.

The land capability classification of the Svea soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 70.

11C—Svea-Buse loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on till plains. The Svea soil is in swales. The Buse soil is on ridges and knolls. Individual areas range from 5 acres to more than 150 acres in size. They are 50 to 60 percent Svea soil and 35 to 45 percent Buse soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown in the lower part. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places the surface soil is clay loam.

Typically, the surface layer of the Buse soil is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the soil is sandy loam throughout. In other places the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Included with these soils in mapping are small areas of moderately well drained Cresbard soils and excessively drained Coe and Sioux soils. These included soils make up 5 to 10 percent of the individual mapped areas. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Svea soil. Coe and Sioux soils are on knobs. They have a gravelly substratum.

Permeability is moderately slow in the Svea and Buse soils. Runoff is rapid. Available water capacity is high. Tilth is good in both soils. The organic matter content is high in the Svea soil and moderately low in the Buse soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. They also are suited to pasture and hay. The hazard of water erosion is severe on both soils. The hazard of soil blowing is slight on the Svea soil and moderate on the Buse soil. Controlling soil erosion and maintaining tilth are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface, including grasses and legumes in the cropping system, providing field windbreaks, providing annual buffer strips, and installing grassed waterways in areas where runoff concentrates help to maintain tilth and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

Smooth bromegrass, intermediate wheatgrass, big bluestem, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are problems, especially if the pasture is overgrazed. They can be controlled by maintaining an adequate cover of the suitable hay or pasture plants.

The Svea soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant, climatically adapted species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification of the Svea soil is IIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 55.

11D—Buse-Svea loams, 9 to 15 percent slopes. These deep, rolling, well drained soils are on till plains. The Buse soil is on knolls and ridges. The Svea soil is in swales. Individual areas range from 5 acres to more than 40 acres in size. They are 50 to 70 percent Buse soil and 30 to 45 percent Svea soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the surface layer and substratum are sandy loam. In other places the dark color of the surface layer extends to a depth of only 3 to 5 inches.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches.

In other places the surface soil is clay loam.

Included with these soils in mapping are small areas of the excessively drained Coe and Sioux soils on knobs. These included soils make up about 5 to 10 percent of the individual mapped areas. The Coe and Sioux soils have a gravelly substratum.

Permeability is moderately slow in the Buse and Svea soils. Runoff is very rapid. Available water capacity is high. Tilth is good in both soils. The organic matter content is moderately low in the Buse soil and high in the Svea soil.

Most areas of these soils are used for cultivated crops. Because of the slope and a severe hazard of water erosion, the soils generally are unsuited to small grain, sunflowers, and flax. They are best suited to range, pasture, and hay.

The important native forage plants on these soils are needleandthread, western wheatgrass, and green needlegrass. Intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. They can be controlled by maintaining an adequate cover of the important or suitable forage plants. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil generally is unsuited and the Svea soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs can be grown on the Buse soil for esthetic purposes or to enhance wildlife habitat if special treatment is applied. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification of the Buse soil is VIe, and that of the Svea soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Svea soil is Silty.

11E—Buse-Svea loams, 15 to 35 percent slopes. These deep, well drained soils are on till plains. The moderately steep and steep Buse soil is on knolls and ridges. The moderately steep Svea soil is in swales. Individual areas range from 5 acres to more than 200 acres in size. They are 40 to 60 percent Buse soil and 30 to 55 percent Svea soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Buse soil is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 5 inches. In other places the substratum is gravelly loam.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the substratum is gravelly loam.

Included with these soils in mapping are small areas of the poorly drained Lamoure soils, well drained Kloten soils, and excessively drained Sioux soils. These included soils make up 5 to 15 percent of the individual mapped areas. Lamoure soils have a thick, dark colored surface soil that is mottled. They are on narrow flood plains. Kloten soils are shallow. They are on ridges. Sioux soils have a gravelly substratum. They are on knolls.

Permeability is moderately slow in the Buse and Svea soils. Runoff is very rapid. Available water capacity is high. The organic matter content is moderately low in the Buse soil and high in the Svea soil.

Most areas of these soils are used for range, pasture, and hay. Because of the slope and a severe hazard of water erosion, the soils generally are unsuited to cultivated crops.

The important native forage plants on these soils are needleandthread, western wheatgrass, and green needlegrass. Intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, smooth bromegrass, and

alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. They can be controlled by maintaining an adequate cover of the important or suitable forage plants. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted if special treatment, such as hand planting or scalp planting, is applied.

These soils are poorly suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The shrink-swell potential is a limitation for buildings sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification of the Buse soil is VIIe, and that of the Svea soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Svea soil is Silty.

12B—Barnes-Buse loams, 3 to 6 percent slopes. These deep, undulating, well drained soils are on till plains. The Barnes soil is on rises and flats. The Buse soil is on ridges and knobs. Individual areas range from 5 acres to more than 400 acres in size. They are 50 to 60 percent Barnes soil and 30 to 40 percent Buse soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Barnes soil is black loam about 8 inches thick. The subsoil is loam about 18 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil and substratum are sandy loam.

Typically, the surface layer of the Buse soil is black loam about 9 inches thick. The subsoil is grayish brown and light olive brown loam about 16 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the dark color of the surface layer extends to a depth of only 6 inches or less. In some places the substratum is sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils and excessively drained Sioux soils. These included soils make up 5 to 15 percent of the individual mapped areas. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats. The Sioux soils have a gravelly substratum. They are on knobs.

Permeability is moderately slow in the Barnes and Buse soils. Runoff is medium. Available water capacity is high. Tilth is good in both soils. The organic matter content is high in the Barnes soil and moderately low in the Buse soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate on both soils. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. Maintaining tilth and controlling erosion are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, providing annual buffer strips, and including grassed waterways in areas where runoff concentrates help to maintain tilth and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant climatically adapted species. Optimum growth, survival, and vigor are unlikely on the Buse soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are suited to septic tank absorption fields and buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field. The shrink-swell potential is a limitation for building sites. Installing

a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 65.

14—Divide loam, 1 to 3 percent slopes. This deep, nearly level, somewhat poorly drained, highly calcareous soil is on flats on outwash plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface soil is black loam about 12 inches thick. The subsoil is grayish brown gravelly loam about 12 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand. In some places the substratum contains more clay and less sand. In other places the substratum is dominantly sand and gravel that has shaly fragments.

Included with this soil in mapping are small areas of the poorly drained Tonka and Vallers soils and well drained Fordville soils. These soils make up 5 to 15 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer and a loam or clay loam substratum. They are in the depressions. Vallers soils have a light brownish gray, mottled subsoil. They are in swales. Fordville soils have a noncalcareous subsoil. They are on low ridges.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Controlling soil blowing and overcoming droughtiness are the main management concerns if cultivated crops are grown. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Soil blowing can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface and by providing field windbreaks and annual buffer strips.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. The poor filtering capacity and the seasonal high water table are limitations for septic tank absorption fields, but these limitations can be overcome by using a mound system. The wetness is a limitation for building sites with basements, but this limitation can be overcome by installing a surface and foundation drainage system. Basements commonly are constructed partially above ground to help overcome the limitation of wetness. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 65.

15—Wyard-Hamerly loams, 0 to 3 percent slopes. These deep, level and nearly level, somewhat poorly drained soils are on till plains. The Wyard soil is in swales. The highly calcareous Hamerly soil is on rises. Individual areas range from 5 acres to more than 300 acres in size. They are 50 to 60 percent Wyard soil and 30 to 40 percent Hamerly soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Wyard soil is black loam about 14 inches thick. It is mottled between depths of 7 and 14 inches. The subsoil is mottled loam about 15 inches thick. It is very dark grayish brown in the upper part and light brownish gray in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the surface layer and subsoil are clay loam. In other places the soil is not mottled above a depth of 36 inches. In a few areas the dark color of the surface soil extends to a depth of only 8 to 16 inches.

Typically, the surface layer of the Hamerly soil is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is

light olive brown, mottled clay loam. In some places the soil is moderately saline. In other places the surface layer is clay loam.

Included with these soils in mapping are small areas of the poorly drained Tonka soils, moderately well drained Cresbard soils, and well drained Barnes soils. These included soils make up about 5 to 15 percent of the individual mapped areas. Tonka soils have a light colored subsurface layer and a subsoil that has an accumulation of clay. They are in shallow depressions. Barnes and Cresbard soils are on rises. Cresbard soils have a dense, alkali subsoil. Barnes soils do not have a mottled or calcareous subsoil.

Permeability is moderate in the Wyard soil and moderately slow in the Hamerly soil. Runoff is slow on both soils. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet in the Wyard soil and 2 to 4 feet in the Hamerly soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of soil blowing is slight on the Wyard soil and moderate on the Hamerly soil. The hazard of water erosion is slight on both soils. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields but are suited to buildings. The moderately slow permeability in the Hamerly soil and the seasonal high water table in both soils are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. Basements commonly are constructed partially above ground to help overcome the wetness limitation.

The land capability classification of the Wyard soil is IIw, and that of the Hamerly soil is IIe. The productivity index of the unit for spring wheat is 85.

16—Hamerly-Tonka loams, 0 to 3 percent slopes. These deep soils are on till plains. The somewhat poorly drained, highly calcareous, nearly level Hamerly soil is on flats surrounding depressions. The poorly drained, level Tonka soil is in the depressions. It is subject to ponding. Individual areas range from 5 acres to more than 2,000 acres in size. They are 55 to 65 percent Hamerly soil and 30 to 40 percent Tonka soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the soil is saline. In other places the surface layer is clay loam. In a few areas the subsoil is noncalcareous.

Typically, the surface layer of the Tonka soil is black loam about 7 inches thick. The subsurface layer is very dark gray, mottled loam about 6 inches thick. The subsoil is mottled and about 38 inches thick. It is very dark grayish brown silty clay loam in the upper part, dark grayish brown silty clay loam in the next part, and grayish brown clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam. In some places the soil does not have a subsurface layer. In other places the soil has a calcareous subsoil. In a few areas the lower part of the substratum is loamy sand.

Included with these soils in mapping are small areas of very poorly drained Parnell soils, moderately well drained Svea soils, and well drained Barnes soils. These included soils make up about 5 to 15 percent of the individual mapped areas. Parnell soils have a subsoil of silty clay loam and silty clay. They are in the deeper part of depressions. Barnes and Svea soils are on rises. Svea soils are dark colored to a depth of more than 16 inches. Barnes soils do not have a mottled subsurface layer or a calcareous subsoil.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the

Hamerly soil and ponded on the Tonka soil. Available water capacity is high. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and is 0.5 foot above to 1.0 foot below the surface of the Tonka soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Tonka soil. The hazard of water erosion is slight on both soils. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. A surface drainage system helps to reduce the wetness in the Tonka soil, but adequate outlets commonly are not readily available. The degree of salinity is greater in some drained areas. If no drainage system is installed, crops are planted and harvested in only about 6 to 8 years out of 10 on the Tonka soil. The common crops can be grown in all years on the Hamerly soil. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The Tonka soil and the ponded water provide breeding sites and habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and water level and controlling siltation.

Drained areas of the Tonka soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas, however, are generally unsuited. The wetness is a critical limitation affecting survival, growth, and vigor. The Hamerly soil is suited to all climatically adapted species. The grasses and weeds growing on both soils, especially on the Tonka soil, are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Hamerly soil generally is poorly suited to septic tank absorption fields but is suited to buildings. Because of ponding, the Tonka soil generally is not suited to building sites and absorption fields. The moderately slow permeability and the seasonal high water table in the Hamerly soil are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. Basements in the Hamerly soil commonly are constructed partially above ground to help overcome the wetness limitation.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat is 65 to 85, depending on the degree of drainage of the Tonka soil.

17—Vallers-Hamerly loams, saline, 0 to 3 percent slopes. These deep, level and nearly level, moderately saline, highly calcareous soils are on till plains. The poorly drained Vallers soil is on flats and in drainageways. The somewhat poorly drained Hamerly soil is on rises. Individual areas range from 5 acres to more than 100 acres in size. They are 55 to 70 percent Vallers soil and 25 to 40 percent Hamerly soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Vallers soil is black loam about 11 inches thick. It contains masses of salt. The subsoil is about 12 inches thick. It is very dark gray loam in the upper part and light olive gray, mottled silty clay loam in the lower part. It contains masses of salt. The substratum to a depth of about 60 inches is mottled clay loam. It is light brownish gray in the upper part and grayish brown in the lower part. In some places the soil is nonsaline. In other places it is strongly saline. In a few areas the surface layer is clay loam.

Typically, the surface layer of the Hamerly soil is very dark gray loam about 8 inches thick. It contains masses of salt. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the soil is nonsaline. In other places the surface layer is clay loam.

Included with these soils in mapping are small areas of the very poorly drained Parnell soils and poorly drained Manfred and Tonka soils in depressions. These included soils make up 5 to 15 percent of the individual mapped areas. They have a subsoil that has an accumulation of clay. In addition, the Tonka soils have a light colored subsurface layer.

Permeability is moderately slow in the Vallers and Hamerly soils. Runoff is slow. Available water capacity is moderate. Salts in both soils reduce the amount of water available to plants. A seasonal high water table is

within a depth of 1 foot in the Vallers soil and is at a depth of 2 to 4 feet in the Hamerly soil. Tilth is fair in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are poorly suited to small grain, sunflowers, and flax. They are best suited to salt-tolerant crops. They also are suited to range, pasture, and hay.

Overcoming wetness and salinity and controlling soil blowing are the main management concerns if cultivated crops are grown. The hazard of water erosion is slight, and that of soil blowing is moderate. A surface drainage system helps to reduce the wetness in the Vallers soil, but adequate outlets commonly are not readily available. The degree of salinity is greater in some drained areas. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to control soil blowing. Conservation tillage and continuous cropping help to reduce surface evaporation and salt concentration at or near the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The important native forage plants on these soils are western wheatgrass, slender wheatgrass, and Nuttall alkaligrass. Tall wheatgrass, slender wheatgrass, altai wildrye, and sweetclover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soils are wet. They can be overcome by deferring grazing when the soil is wet. Soil blowing is also a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

These soils are suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity, which is caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

The Hamerly soil is poorly suited to septic tank absorption fields but is suited to buildings. Because of the wetness, moderately slow permeability, and shrink-swell potential, the Vallers soil generally is not suited to building sites and absorption fields. The moderately slow permeability and the seasonal high water table in the Hamerly soil are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. Basements in the Hamerly soil commonly are constructed partially above ground to help overcome the wetness.

The land capability classification of both soils is IIIs. The productivity index of the unit for spring wheat is 35 to 50, depending on the degree of drainage and salinity. The range site of both soils is Saline Lowland.

19—Hamerly-Cresbard loams, 1 to 3 percent slopes. These deep, nearly level soils are on till plains. The somewhat poorly drained, highly calcareous Hamerly soil is on flats and in swales. The moderately well drained, alkali Cresbard soil is on rises. Individual areas range from 5 acres to more than 300 acres in size. They are 40 to 50 percent Hamerly soil and 40 to 50 percent Cresbard soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Hamerly soil is very dark gray loam about 8 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled clay loam. In some places the soil is moderately saline. In other places the surface layer is clay loam. In a few areas the subsoil is noncalcareous.

Typically, the surface layer of the Cresbard soil is black loam about 8 inches thick. The next layer is very dark gray clay loam about 1 inch thick. The subsoil is about 28 inches thick. It is black clay loam in the upper part, very dark grayish brown clay loam in the next part, and grayish brown loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the subsoil is mottled. In a few areas the subsoil is less than 9 inches thick.

Included with these soils in mapping are small areas of the poorly drained Tonka and Vallers soils, moderately well drained Svea soils, and well drained Barnes soils. These included soils make up 5 to 10

percent of the individual mapped areas. Tonka soils have a light colored, mottled subsurface layer. They are in depressions. Vallers soils have a mottled subsoil and a light brownish gray, mottled substratum. They are in swales. Svea soils have a dark colored surface soil more than 16 inches thick. They occur as areas intermingled with areas of the Cresbard soil. Barnes soils have a loam subsoil. They are on rises.

Permeability is moderately slow in the Hamerly soil and slow in the Cresbard soil. Runoff is slow on both soils. Available water capacity is high in the Hamerly soil and moderate in the Cresbard soil. The dense subsoil of the Cresbard soil restricts root penetration. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and is at a depth of 4 to 6 feet in the Cresbard soil. Tilth is fair in both soils. The organic matter content is high in the Hamerly soil and moderate in the Cresbard soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate on the Hamerly soil and slight on the Cresbard soil. The hazard of water erosion is slight on both soils. Overcoming wetness and controlling soil blowing on the Hamerly soil and maintaining tilth in the Cresbard soil are the main management concerns if cultivated crops are grown. Wetness of the Hamerly soil can be overcome by delaying tillage and planting. Because of moisture stress in most years, crop growth is uneven on the Cresbard soil, especially as the crop nears maturity. The best time for tillage is when the Cresbard soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage improves tilth. Growing deep-rooted legumes, such as alfalfa, improves the penetration of roots in the dense subsoil of the Cresbard soil. Applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, and providing annual buffer strips help to improve tilth and control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The Hamerly soil is suited to all and the Cresbard soil to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs in the Cresbard soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity, which is caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

These soils are poorly suited to septic tank absorption fields but are suited to buildings. The moderately slow and slow permeability and the seasonal high water table are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. Basements in the Hamerly soil commonly are constructed partially above ground to help overcome the wetness limitation.

The land capability classification of the Hamerly soil is IIe, and that of the Cresbard soil is IIIs. The productivity index of the unit for spring wheat is 80.

20—Cresbard-Svea loams, 1 to 3 percent slopes. These deep, nearly level, moderately well drained soils are on till plains. The alkali Cresbard soil is on flats and rises. The Svea soil is in swales. Individual areas range from about 5 acres to more than 200 acres in size. They are about 50 to 60 percent Cresbard soil and 30 to 40 percent Svea soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cresbard soil is black loam about 8 inches thick. The next layer is very dark gray clay loam about 1 inch thick. The subsoil is about 28 inches thick. In sequence downward, it is black clay loam, very dark grayish brown clay loam, grayish brown silt loam, and grayish brown loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the surface layer is clay loam.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown loam in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown and mottled in the lower part. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the surface soil is clay loam.

Included with these soils in mapping are small areas of the poorly drained Tonka soils, somewhat poorly drained Hamerly soils, and well drained Buse soils. These included soils make up about 5 to 20 percent of

the individual mapped areas. Tonka soils have a light colored subsurface layer. They are in shallow depressions. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats adjacent to depressions. Buse soils have a calcareous subsoil. They are on ridges and knolls.

Permeability is slow in the Cresbard soil and moderately slow in the Svea soil. Runoff is slow on both soils. Available water capacity is moderate in the Cresbard soil and high in the Svea soil. The dense subsoil of the Cresbard soil restricts root penetration. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Tilth is fair in the Cresbard soil and good in the Svea soil. The organic matter content is moderate in the Cresbard soil and high in the Hamerly soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazards of water erosion and soil blowing are slight. Maintaining or improving tilth, especially in the alkali Cresbard soil, is the main management concern if cultivated crops are grown. Because of moisture stress in most years, crop growth is uneven on the Cresbard soil, especially as the crop nears maturity. The best time for tillage is when the Cresbard soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage and additions of organic material into the soils improve tilth. Growing deep-rooted legumes, such as alfalfa, improves the penetration of roots in the dense subsoil of the Cresbard soil. Applying a conservation tillage system that includes leaving crop residue on the surface helps to maintain or improve tilth and control localized soil erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The Cresbard soil is suited to many and the Svea soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs in the Cresbard soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity, which is caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields but are suited to buildings. The moderately slow and slow permeability and the seasonal high water table are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements.

The land capability classification of the Cresbard soil is IIIs, and that of the Svea soil is IIc. The productivity index of the unit for spring wheat is 80.

20B—Cresbard-Svea loams, 3 to 6 percent slopes. These deep, undulating, moderately well drained soils are on till plains. The alkali Cresbard soil is on rises. The Svea soil is in swales. Individual areas range from 5 acres to more than 100 acres in size. They are 30 to 50 percent Cresbard soil and 30 to 50 percent Svea soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cresbard soil is black loam about 8 inches thick. The next layer is very dark gray loam about 1 inch thick. The subsoil is about 28 inches thick. In sequence downward, it is black clay loam, very dark grayish brown clay loam, grayish brown clay loam, and grayish brown loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the surface layer is clay loam.

Typically, the surface soil of the Svea soil is black loam about 14 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part and light yellowish brown in the lower part. The substratum to a depth of about 60 inches is loam. It is dark grayish brown in the upper part and olive brown in the lower part. In some places the surface soil is clay loam. In other places the dark color of the surface soil extends to a depth of only 8 to 16 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils and well drained Buse soils. These included soils make up 5 to 20 percent of the individual mapped areas. Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats. Buse soils have a calcareous subsoil. They are on ridges and knolls.

Permeability is slow in the Cresbard soil and moderately slow in the Svea soil. Runoff is medium on both soils. Available water capacity is moderate in the Cresbard soil and high in the Svea soil. The dense subsoil of the Cresbard soil restricts root penetration. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Tilth is fair in the Cresbard soil and good in

the Svea soil. The organic matter content is moderate in the Cresbard soil and high in the Svea soil.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Maintaining tilth, especially in the alkali Cresbard soil, and controlling water erosion are the main management concerns if cultivated crops are grown. Because of moisture stress in most years, crop growth is uneven on the Cresbard soil, especially as the crop nears maturity. The best time for tillage is when the Cresbard soil is neither too wet nor too dry. Timely tillage and additions of organic material help to improve tilth. Growing deep-rooted legumes, such as alfalfa, improves the penetration of roots in the dense subsoil of the Cresbard soil. Applying a conservation tillage system that includes leaving crop residue on the surface and installing grassed waterways in areas where runoff concentrates help to maintain or improve tilth and control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The Cresbard soil is suited to many and the Svea soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs in the Cresbard soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields but are suited to buildings. The moderately slow and slow permeability and the seasonal high water table are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements.

The land capability classification of the Cresbard soil is IIIe, and that of the Svea soil is IIe. The productivity index of the unit for spring wheat is 70.

21—Cavour-Cresbard loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained, alkali soils are on till plains. The Cavour soil is in swales. The Cresbard soil is on rises. Individual areas range from 5 acres to more than 500 acres in size. They are 40 to 55 percent Cavour soil and 30 to 40 percent Cresbard soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Cavour soil is black loam about 7 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 33 inches thick. It is very dark gray and very dark grayish brown clay in the upper part, dark grayish brown clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places salts are within 16 inches of the surface. In other places the soil does not have masses of salt and gypsum in the subsoil. In a few areas the surface layer is clay loam.

Typically, the surface layer of the Cresbard soil is black loam about 8 inches thick. The next layer is very dark gray loam about 1 inch thick. The subsoil is about 28 inches thick. In sequence downward, it is black clay loam, very dark grayish brown clay loam, grayish brown clay loam, and grayish brown loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some places the soil does not have masses of gypsum in the subsoil. In other places the surface layer is clay loam.

Included with these soils in mapping are small areas of the poorly drained Manfred and Vallers soils, somewhat poorly drained Hamerly soils, and moderately well drained Svea soils. These included soils make up about 10 to 20 percent of the individual mapped areas. Manfred soils have a mottled subsoil. They are in shallow depressions. Vallers and Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats adjacent to depressions. Svea soils do not have a dense, alkali subsoil. They occur as areas intermingled with areas of the Cresbard soil.

Permeability is very slow in the Cavour soil and slow in the Cresbard soil. Runoff is slow on both soils. Available water capacity is moderate. The dense subsoil of both soils restricts root penetration. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Tilth is poor in the Cavour soil and fair in the Cresbard soil. The organic matter content is moderate in both soils.

Most areas of these soils are used for cultivated crops. The soils are poorly suited to small grain, sunflowers, and flax. The hazards of water erosion and soil blowing are slight. Maintaining or improving tilth is the main management concern if cultivated crops are

grown. Because of moisture stress in most years, crop growth is uneven on these soils, especially as the crop nears maturity. The best time for tillage is when the soils are neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage and additions of organic material help to improve tilth. Growing deep-rooted legumes, such as alfalfa, improves the penetration of roots in the dense subsoil of these soils. Applying a conservation tillage system that includes leaving crop residue on the surface helps to maintain or improve tilth and control localized soil erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

The Cavour soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many species. Supplemental watering and control of weedy ground cover help to ensure the survival of the seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil.

These soils are poorly suited to septic tank absorption fields but are suited to buildings. The slow and very slow permeability and the seasonal high water table are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements.

The land capability classification of the Cavour soil is IVs, and that of the Cresbard soil is IIIs. The productivity index of the unit for spring wheat is 50.

22—Miranda-Cavour loams. These deep, level, alkali soils are on till plains. The somewhat poorly drained Miranda soil is in swales. The moderately well drained Cavour soil is on rises. Individual areas range from 5 acres to more than 50 acres in size. They are 40 to 55 percent Miranda soil and 30 to 55 percent Cavour soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Miranda soil is black loam about 8 inches thick. The subsoil is clay loam about 24 inches thick. It is black and dark brown in the upper part, very dark grayish brown in the next part, and grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled clay loam. In some places the subsoil is clay. In other places the surface layer is clay loam.

Typically, the surface layer of the Cavour soil is black loam about 7 inches thick. The subsurface layer is very dark gray loam about 2 inches thick. The subsoil is about 33 inches thick. It is very dark gray and very dark grayish brown clay in the upper part, dark grayish brown clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the soil does not have a subsurface layer. In other places the surface layer is clay loam. In a few areas the soil does not have masses of salt in the subsoil and substratum.

Included with these soils in mapping are small areas of poorly drained Manfred and Vallers soils and moderately well drained Svea soils. These included soils make up about 5 to 20 percent of the individual mapped areas. Manfred soils have a mottled subsoil. They are in shallow depressions. Vallers soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats. Svea soils are nonalkali. They occur as areas intermingled with areas of the Cavour soil.

Permeability is very slow in the Miranda and Cavour soils. Runoff is slow. Available water capacity is moderate. The dense subsoil of both soils restricts root penetration. A seasonal high water table is at a depth of 2 to 4 feet in the Miranda soil and is at a depth of 4 to 6 feet in the Cavour soil. Tilth is poor in both soils. The organic matter content is moderate in both soils.

Most areas of these soils are used for cultivated crops. Because the soils are alkali, they generally are unsuited to small grain, sunflowers, and flax. They are best suited to range, pasture, and hay.

The important native forage plants on these soils are western wheatgrass and blue grama. Western wheatgrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Slow plant regrowth after grazing is a problem on these soils. This problem can be overcome by using a planned grazing system.

The Miranda soil generally is unsuited to trees and shrubs grown as windbreaks and environmental plantings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Supplemental watering and control of weedy ground cover help to ensure the survival of the seedlings on the Cavour soil. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited

available water capacity caused by the salts in the soil.

These soils are poorly suited to septic tank absorption fields and buildings. The very slow permeability and the seasonal high water table are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements.

The land capability classification of the Miranda soil is VIs, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 0. The range site of the Miranda soil is Thin Claypan, and that of the Cavour soil is Claypan.

23B—Mekinock loam, 0 to 6 percent slopes. This moderately deep, level to gently sloping, moderately well drained, alkali soil is on flats and rises on till plains. Individual areas range from 5 acres to more than 50 acres in size.

Typically, the surface layer is very dark gray loam about 2 inches thick. The subsoil is very dark grayish brown clay about 14 inches thick. The substratum to a depth of about 25 inches is dark olive gray clay. Below this is shale. In some places the depth to shale is more than 40 inches. In a few areas the surface layer is clay loam.

Included with this soil in mapping are small areas of moderately well drained Hattie soils. These soils make up about 5 to 10 percent of the individual mapped areas. Hattie soils are nonalkali. They occur as areas intermingled with areas of the Mekinock soil.

Permeability is very slow in the Mekinock soil. Runoff is medium. Available water capacity is low. The dense subsoil restricts root penetration. The organic matter content is high.

Most areas of this soil are used for pasture or range. Because the soil is alkali, it generally is unsuited to small grain, sunflowers, flax, and trees and shrubs. It is best suited to range, pasture, or hay.

The important native forage plants are western wheatgrass and blue grama. Slender wheatgrass and crested wheatgrass are suitable hay and pasture plants. Slow plant regrowth after grazing is a problem. This can be overcome by using a planned grazing system.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. The very slow permeability and the depth to shale are limitations for septic tank absorption fields, but they can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Thin Claypan.

25—Hattie clay, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flats on till plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black clay about 7 inches thick. The subsoil is clay about 20 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown clay. In some places the surface layer is clay loam or silty clay loam. In other places the soil has a subsurface layer. In a few areas the dark color of the surface layer extends to a depth of more than 20 inches.

Included with this soil in mapping are small areas of the moderately well drained Mekinock soils and poorly drained Hegne soils. These soils make up about 5 to 10 percent of the individual mapped areas. Mekinock soils have a dense, alkali subsoil. They are in swales. Hegne soils have a layer that has an accumulation of lime within 16 inches of the surface and have a grayish substratum. They are in narrow drainageways.

Permeability is slow in the Hattie soil. Runoff is slow. Available water capacity is moderate. Tilth is poor. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Improving tilth and controlling soil blowing are the main management concerns if cultivated crops are grown. The best time to till is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface helps to protect the soil from crusting under heavy rainfall and helps to improve infiltration. Using annual buffer strips, field windbreaks, and a conservation tillage system helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds

before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field or by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is IIs. The productivity index for spring wheat is 85.

26—Rolette clay loam, 1 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flats on mantled delta plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The next layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 37 inches thick. It is very dark grayish brown silty clay in the upper part and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the soil is slightly acid or medium acid. In other places the surface layer is silty clay or clay. In a few areas the surface layer is dark gray.

Included with this soil in mapping are small areas of the poorly drained Hegne soils and moderately well drained Cresbard soils. These soils make up about 5 to 15 percent of the individual mapped areas. Hegne soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are in narrow drainageways. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Rolette soil.

Permeability is moderately slow in the Rolette soil. Runoff is slow. Available water capacity is high. Tilth is fair. The organic matter content is high.

Most areas of this soil are used for cultivated crops. A few small areas are used as woodland. This soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Maintaining tilth and controlling soil blowing are the main management concerns if cultivated crops are grown. The best time to till is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface helps to protect the soil from crusting under heavy rainfall and helps to improve infiltration. Using annual buffer strips, field windbreaks, and a conservation tillage system helps to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field or by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is IIc. The productivity index for spring wheat is 85.

26B—Rolette clay loam, 3 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on mid and lower foot slopes on mantled delta plains. Individual areas range from 5 acres to more than 200 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The next layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 37 inches thick. It is very dark grayish brown silty clay in the upper part and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the soil is slightly acid or medium acid. In other places the surface layer is silty clay or clay. In a few areas the surface layer is dark gray.

Included with this soil in mapping are small areas of the moderately well drained Cresbard soils. These soils make up about 5 to 10 percent of the individual mapped areas. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Rolette soil.

Permeability is moderately slow in the Rolette soil.

Runoff is medium. Available water capacity is high. Tilth is fair. The organic matter content is high.

Most areas of this soil are used for cultivated crops. A few small areas are used as woodland. This soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are moderate. Maintaining tilth and controlling erosion are the main management concerns if cultivated crops are grown. The best time for tillage is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface helps to protect the soil from crusting under heavy rainfall and helps to improve infiltration. Using annual buffer strips, field windbreaks, a conservation tillage system, and grassed waterways in areas where runoff concentrates helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field or by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is IIe. The productivity index for spring wheat is 75.

26C—Rolette silty clay loam, 6 to 9 percent slopes. This deep, moderately sloping, moderately well drained soil is on the upper part of foot slopes on mantled delta plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The next layer is very dark grayish brown silty clay about 4 inches thick. The subsoil is very dark grayish brown silty clay about 15 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay in the upper part and dark olive gray clay loam in the lower part. In some places the soil is slightly acid or medium acid. In other places the surface layer is silty clay or clay. In a few areas the surface layer is dark gray.

Included with this soil in mapping are small areas of the well drained Buse soils. These soils make up 5 to 15 percent of the individual mapped areas. Buse soils have a calcareous subsoil. They are on shoulder slopes.

Permeability is moderately slow in the Rolette soil. Runoff is rapid. Available water capacity is high. Tilth is fair. The organic matter content is high.

Most areas of this soil are used for cultivated crops. A few small areas are used as woodland. This soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is severe. Maintaining tilth and controlling erosion are the main management concerns if cultivated crops are grown. The best time to till is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface helps to protect the soil from crusting under heavy rainfall and helps to improve infiltration. Using annual buffer strips, field windbreaks, a conservation tillage system, and grassed waterways in areas where runoff concentrates helps to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is suited to septic tank absorption fields and buildings. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field or by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is IIIe. The productivity index for spring wheat is 60.

27D—Olga silty clay loam, 9 to 15 percent slopes. This deep, strongly sloping, well drained soil is on side slopes on dissected till plains. Individual areas range from 5 acres to more than 150 acres in size.

Typically, about 1 inch of partially decomposed leaves, grass, and roots is at the surface. The surface layer is black silty clay loam about 7 inches thick. The subsurface layer is dark gray silty clay loam about 5 inches thick. The subsoil is silty clay about 18 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum is dark gray channery silty clay about 20 inches thick. Below this is shale. In some places the soil does not have a subsurface layer and the surface layer is silty clay. In a few areas the soil contains less clay throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Cashel soils and well drained Kloten soils. These soils make up about 5 to 20 percent of the individual mapped areas. Cashel soils have a stratified substratum. They are on flood plains. Kloten soils are shallow. They are on shoulder slopes.

Permeability is slow in the Olga soil. Runoff is rapid. Available water capacity is moderate. Tilth is fair. The organic matter content is moderate.

Most areas of this soil are used as woodland wildlife habitat or woodland pasture. A few areas are used for cultivated crops. Because of the slope and the severe hazard of water erosion, this soil is very poorly suited to small grain, sunflowers, and flax, but it is suited to hay and pasture. It is best suited to woodland wildlife habitat or woodland pasture. Where this soil is used for woodland pasture, using a planned grazing system helps to protect the soil from erosion and to maintain or improve the vigor of important pasture plants. It also helps to maintain plant cover for woodland wildlife and permits regrowth of browse plants. Bur oak is the dominant species of tree. The understory is beaked hazel and serviceberry. These species provide excellent food and cover for wildlife. Maintaining tilth and controlling water erosion are the main management concerns if cultivated crops are grown. The best time to till is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface, installing terraces and grassed waterways, and including grasses and legumes in the cropping system help to protect the soil from water erosion.

Orchardgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Water erosion is a problem, especially if the pasture is overgrazed. Maintaining an adequate cover of the suitable forage plants helps to control water erosion.

This soil generally is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and buildings. The slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The limitation of slope on building sites and septic tank absorption fields can be overcome by designing buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification is IVe. The productivity index for spring wheat is 40.

27E—Olga silty clay loam, 15 to 35 percent slopes. This deep, moderately steep and steep, well drained soil is on side slopes on dissected till plains. Individual areas range from 20 acres to more than 500 acres in size.

Typically, a 1-inch cover of partially decomposed leaves, grass, and roots is at the surface. The surface layer is black silty clay loam about 7 inches thick. The subsurface layer is dark gray silty clay loam about 5 inches thick. The subsoil is silty clay about 18 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum is dark gray channery silty clay about 20 inches thick. Below this is shale. In some places the surface layer is dark gray. In other places the soil does not have a subsurface layer and the surface layer is silty clay. In a few areas the soil contains less clay throughout.

Included with this soil in mapping are small areas of the well drained Edgeley and Kloten soils on shoulder slopes. These soils make up about 5 to 15 percent of the individual mapped areas. Edgeley soils are moderately deep. Kloten soils are shallow.

Permeability is slow in the Olga soil. Runoff is rapid. Available water capacity is moderate. The organic matter content is moderate.

Most areas of this soil are used as woodland wildlife

habitat or woodland pasture. Because of the slope and the severe hazard of water erosion, this soil generally is unsuited to small grain, sunflowers, flax, pasture, and hay. It is best suited to woodland wildlife habitat or woodland pasture. Where used for native pasture, using a planned grazing system helps to protect the soil from erosion and to maintain or improve the vigor of important pasture plants. It also helps to maintain plant cover for woodland wildlife and permits regrowth of browse plants. Bur oak is the dominant species of tree. The understory is beaked hazel and serviceberry. These species provide excellent food and cover for wildlife.

This soil is poorly suited to septic tank absorption fields and buildings. The slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation for building sites, but installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The limitation of slope on building sites and septic tank absorption fields can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land.

The land capability classification is VIIe. The productivity index for spring wheat is 0.

30F—Kloten-Walsh-Edgeley loams, 6 to 35 percent slopes. These well drained soils are in valleys on dissected till plains. The shallow, moderately sloping to steep Kloten soil is on shoulder slopes. The deep, moderately sloping and strongly sloping Walsh soil is on foot slopes. The moderately deep, moderately sloping and strongly sloping Edgeley soil is on side slopes. Shale is exposed on some of the steep cutbanks and in slump areas. Individual areas range from 50 acres to more than 500 acres in size. They are 50 to 70 percent Kloten soil, 10 to 30 percent Walsh soil, and 10 to 30 percent Edgeley soil. The three soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Kloten soil is very dark gray loam about 7 inches thick. The substratum is very dark grayish brown channery loam about 7 inches thick. Below this is shale. In some places the surface layer is channery loam. In other places the shale is within 5 to 8 inches of the surface.

Typically, the surface soil of the Walsh soil is black loam about 11 inches thick. The subsoil is loam about 24 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown loam.

Typically, the surface layer of the Edgeley soil is black loam about 9 inches thick. The subsoil is about 18 inches thick. It is very dark gray loam in the upper part and dark grayish brown channery loam in the lower part. Below this is shale.

Included with these soils in mapping are small areas of the well drained Buse soils. These included soils make up about 5 to 10 percent of the individual mapped areas. The Buse soils have a highly calcareous subsoil and do not have shale within 40 inches of the surface. They are on shoulder slopes above the Kloten soil.

Permeability is moderate in the Kloten, Walsh, and Edgeley soils. Runoff is rapid. Available water capacity is very low in the Kloten soil, low in the Edgeley soil, and high in the Walsh soil. Shale restricts the rooting depth in the Kloten and Edgeley soils. The organic matter content is high in all three soils.

Most areas of these soils are used for range. Some moderately sloping areas are used for cultivated crops, pasture, or hay. Because of the slope and the severe hazard of water erosion, these soils generally are unsuited to cultivated crops and hay. They are best suited to range.

The important native forage plants are needleandthread, green needlegrass, and western wheatgrass. Meadow bromegrass, smooth bromegrass, green needlegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. It can be controlled by maintaining an adequate cover of the important or suitable forage plants. Reestablishing vegetation is difficult in denuded areas of the Kloten soil. The slope limits the use of machinery. Gullies can form along cattle trails. A planned grazing system that controls the pattern of livestock traffic helps to control gullying.

The Walsh soil is suited to all and the Edgeley soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Kloten soil generally is unsuited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. In areas of the Kloten soil, trees and shrubs can be grown for esthetic purposes or to improve wildlife habitat if special treatment, such as hand planting or scalp planting, is applied.

The Kloten soil generally is unsuited to septic tank absorption fields and buildings because of the slope and the depth to bedrock. The Edgeley soil is poorly suited to septic tank absorption fields but is suited to

buildings. The Walsh soil is suited to both septic tank absorption fields and buildings. The moderate permeability in the Walsh soil is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field. The depth to shale in the Edgeley soil is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The slope is a limitation on sites for buildings and septic tank absorption fields, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The shrink-swell potential of the Edgeley and Walsh soils is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification of the Kloten soil is VIIe, and that of the Walsh and Edgeley soils is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Kloten soil is Shallow, and that of the Walsh and Edgeley soils is Silty.

31C—Binford sandy loam, 1 to 9 percent slopes. This deep, nearly level to moderately sloping, somewhat excessively drained soil is on flats and ridges on delta plains. Individual areas range from 5 acres to more than 40 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is very dark grayish brown sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is dark grayish brown gravelly sand in the upper part, grayish brown gravelly coarse sand in the next part, and gray sand in the lower part. In some places the substratum is mostly siliceous sand and gravel. In other places the subsoil extends to a depth of 25 to 35 inches.

Included with this soil in mapping are small areas of the moderately well drained Inkster soils and excessively drained Coe soils. These included soils make up about 5 to 15 percent of the individual mapped areas. Inkster soils have a surface soil and substratum that contain more clay than those of the Binford soil. They are in swales. Coe soils have sand and gravel at a depth of 6 to 14 inches. They occur as areas intermingled with areas of the Binford soil.

Permeability is rapid in the Binford soil. Runoff is medium. Available water capacity is low. Tilth is good. The organic matter content is moderate.

Most areas of this soil are used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. It is best suited to pasture or hay. The hazard of water erosion is moderate, and that of soil blowing is severe. Controlling soil erosion and overcoming droughtiness are the main management concerns if cultivated crops are grown. Soil erosion can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface and by providing field windbreaks and installing grassed waterways in areas where runoff concentrates. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

Intermediate wheatgrass, western wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the pasture is overgrazed. They can be controlled by maintaining an adequate cover of the suitable hay and pasture plants.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. This soil is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is well suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 35.

32—Brantford loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on outwash plains and delta plains. Individual areas range from 5 acres to more than 500 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is very dark grayish brown loam about 8 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly coarse sand in the upper part, dark grayish

brown gravelly coarse sand in the next part, and very dark grayish brown very gravelly coarse sand in the lower part. In some places the substratum is mostly siliceous sand and gravel. In other places the subsoil extends to a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of the moderately well drained Walsh soils and excessively drained Coe soils. These soils make up about 5 to 15 percent of the individual mapped areas. Walsh soils have a nongravelly substratum. They occur as areas intermingled with areas of the Brantford soil. Coe soils have sand and gravel at a depth of 6 to 14 inches. They are on rises.

Permeability is moderate in the upper part of the Brantford soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Overcoming droughtiness is the main management concern if cultivated crops are grown. Droughtiness can be overcome by applying a conservation tillage system that includes leaving crop residue on the surface. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. This soil is droughty, and trees and shrubs commonly are affected by moisture stress. Irrigation or supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and well suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 50.

33—Vang loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on outwash plains and delta plains. Individual areas range from 5 acres to more than 200 acres in size.

Typically, the surface soil is black loam about 11 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown. It is clay loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly sand. In some places the substratum is mostly siliceous sand and gravel. In other places the subsoil extends to a depth of only 14 to 20 inches. In a few areas the substratum is loamy sand.

Included with this soil in mapping are small areas of the moderately well drained Walsh soils. These soils make up about 5 to 15 percent of the individual mapped areas. Walsh soils have a nongravelly substratum. They occur as areas intermingled with areas of the Vang soil.

Permeability is moderate in the upper part of the Vang soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Overcoming droughtiness is the main management concern if cultivated crops are grown. Droughtiness can be overcome by applying a conservation tillage system that includes leaving crop residue on the surface. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

This soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. This soil is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Irrigation or supplemental watering helps ensure survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and is well suited to building sites. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the

pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIs. The productivity index for spring wheat is 60.

33B—Vang-Coe complex, 3 to 6 percent slopes. These deep, undulating soils are on outwash plains, delta plains, and eskers. The well drained Vang soil is on flats and in swales. The excessively drained Coe soil is on ridges. Individual areas range from 5 acres to more than 150 acres in size. They are 30 to 60 percent Vang soil and 20 to 45 percent Coe soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vang soil is black loam about 11 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown. It is clay loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly sand. In some places the substratum is mostly siliceous sand and gravel. In other places the subsoil extends to a depth of only 14 to 20 inches. In a few areas the substratum is very gravelly loam.

Typically, the surface layer of the Coe soil is black gravelly loam about 7 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand. In some places the substratum is mostly siliceous sand and gravel. In other places the soil has a subsoil. In a few areas the surface layer is sandy loam.

Included with these soils in mapping are small areas of the moderately well drained Svea and Walsh soils. These included soils make up about 10 to 20 percent of the individual mapped areas. Svea and Walsh soils have a nongravelly substratum. They occur as areas intermingled with areas of the Vang soil.

Permeability is moderate in the upper part of the Vang and Coe soils and very rapid in the lower part. Runoff is medium on the Vang soil and slow on the Coe soil. Available water capacity is low in the Vang soil and very low in the Coe soil. Tilth is good in both soils. The organic matter content is high in the Vang soil and moderate in the Coe soil.

Most areas of these soils are used for cultivated crops. The soils are poorly suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Controlling water erosion and overcoming droughtiness are the main concerns if cultivated crops are grown. Water erosion can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

The Vang soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Coe soil generally is unsuited to trees and shrubs. The Vang soil is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields but are well suited to buildings. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the Vang soil is IIIe, and that of the Coe soil is VIs. The productivity index of the unit for spring wheat is 45.

33C—Vang-Coe complex, 6 to 9 percent slopes. These deep, gently rolling soils are on outwash plains, delta plains, and eskers. The well drained Vang soil is in swales. The excessively drained Coe soil is on ridges and knolls. Individual areas range from 5 acres to more than 40 acres in size. They are 30 to 60 percent Vang soil and 25 to 50 percent Coe soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Vang soil is black loam about 11 inches thick. The subsoil is about 16 inches thick. It is very dark grayish brown. It is clay loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown very gravelly sand. In some places the substratum is mostly siliceous sand and gravel. In other places the subsoil extends to a depth of only 14 to 20 inches. In a few areas the substratum is very gravelly loam.

Typically, the surface layer of the Coe soil is black

gravelly loam about 7 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand. In some places the substratum is mostly siliceous sand and gravel. In other places the soil has a subsoil. In a few areas the surface layer is sandy loam.

Included with these soils in mapping are small areas of the moderately well drained Walsh soils. These included soils make up about 5 to 20 percent of the individual mapped areas. Walsh soils have a nongravelly substratum. They occur as areas intermingled with areas of the Vang soil.

Permeability is moderate in the upper part of the profile of the Vang and Coe soils and very rapid in the lower part. Runoff is medium on both soils. Available water capacity is low in the Vang soil and very low in the Coe soil. Tilth is good in both soils. The organic matter content is high in the Vang soil and moderate in the Coe soil.

Most areas of these soils are used for cultivated crops. The soils are poorly suited to small grain, sunflowers, and flax. They are best suited to hay or pasture. The hazard of water erosion is severe, and that of soil blowing is slight. Controlling water erosion and overcoming droughtiness are the main management concerns if cultivated crops are grown. Water erosion can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface, including grasses and legumes in the cropping system, and installing grassed waterways in areas where runoff concentrates. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

Crested wheatgrass, western wheatgrass, intermediate wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion is a problem, especially if the pasture is overgrazed. It can be controlled by maintaining an adequate cover of the suitable hay and pasture plants.

The Vang soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Coe soil generally is unsuited to trees and shrubs. The Vang soil is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields but are well suited to buildings. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the Vang soil is IVe, and that of the Coe soil is VIs. The productivity index of the unit for spring wheat is 40.

34—Walsh-Vang loams, 0 to 3 percent slopes. These deep, level and nearly level, well drained soils are on water-smoothed till plains and on outwash plains. The Walsh soil is in swales and on flats. The Vang soil is on rises. Individual areas range from 10 acres to more than 400 acres in size. They are 55 to 85 percent Walsh soil and 15 to 40 percent Vang soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Walsh soil is black loam about 9 inches thick. The subsoil is loam about 34 inches thick. It is very dark grayish brown in the upper part, dark grayish brown in the next part, and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown gravelly loam. In some places the surface layer is fine sandy loam. In other places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In a few areas the substratum is sandy loam.

Typically, the surface layer of the Vang soil is black loam about 9 inches thick. The subsoil is about 28 inches thick. It is very dark grayish brown loam in the upper part, dark brown loam in the next part, and light brownish gray gravelly loam in the lower part. The substratum to a depth of about 60 inches is very gravelly sand. It is dark grayish brown in the upper part and dark olive gray in the lower part. In some places the dark color of the surface layer extends to a depth of only 8 to 16 inches. In other places the substratum is mostly siliceous sand and gravel. In a few areas the soil is underlain by highly fractured shale at a depth of 40 to 60 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils and well drained Brantford soils. These included soils make up about 5 to 10 percent of the individual mapped areas. Hamerly soils have a subsoil that has an accumulation

of lime within 16 inches of the surface. They are on flats. Brantford soils have a sand and gravel substratum at a depth of 14 to 20 inches. They are on low ridges and knolls.

Permeability is moderate in the Walsh soil. It is moderate in the upper part of the profile of the Vang soil and very rapid in the lower part. Runoff is slow on both soils. Available water capacity is high in the Walsh soil and low in the Vang soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Maintaining tilth, controlling water erosion and overcoming droughtiness of the Vang soil are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface helps to maintain tilth, conserve moisture, and control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

The Walsh soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Vang soil is suited to some of the climatically adapted species. It is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

The Walsh soil is suited to septic tank absorption fields, but the Vang soil is poorly suited. The Walsh soil is suited and the Vang soil is well suited to buildings. The moderate permeability of the Walsh soil is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. Because of the rapid permeability, the Vang soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The shrink-swell potential of the Walsh soil is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The sides of shallow excavations, such as those of basements, in the Vang soil tend to cave in unless they are shored.

The land capability classification of the Walsh soil is IIc, and that of the Vang soil is IIs. The productivity index of the unit for spring wheat is 85.

34B—Walsh, sand substratum-Vang loams, 3 to 6 percent slopes. These deep, undulating, well drained soils are on water-smoothed till plains and on outwash plains. The Walsh soil is in swales. The Vang soil is on rises. Individual areas range from 5 acres to more than 70 acres in size. They are 55 to 75 percent Walsh soil and 20 to 35 percent Vang soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface soil of the Walsh soil is black loam about 9 inches thick. The subsoil is loam about 26 inches thick. It is very dark grayish brown in the upper part and light olive brown in the lower part. The upper part of the substratum is dark grayish brown gravelly loam. The lower part to a depth of about 60 inches is very dark grayish brown gravelly loamy sand. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the subsoil and substratum are fine sandy loam.

Typically, the surface soil of the Vang soil is black loam about 12 inches thick. The subsoil is very dark grayish brown loam about 13 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown. It is gravelly loam in the upper part and gravelly loamy sand in the lower part. In some places the substratum is mostly siliceous sand and gravel. In other places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In a few areas the soil is underlain by highly fractured shale at a depth of more than 40 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Divide and Hamerly soils, well drained Brantford soils, and excessively drained Coe soils. These included soils make up about 5 to 15 percent of the individual mapped areas. Divide and Hamerly soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are on flats. Brantford and Coe soils are on ridges and knolls. Brantford soils have a sand and gravel substratum at a depth of 14 to 20 inches. Coe soils have a sand and gravel substratum at a depth of 6 to 14 inches.

Permeability is moderate in the upper part of the Walsh and Vang soils and very rapid in the lower part. Runoff is medium on both soils. Available water capacity is moderate in the Walsh soil and low in the

Vang soil. Tilth is good in both soils. The organic matter content is high in both soils.

Most areas of these soils are used for cultivated crops. The soils are suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Maintaining tilth, controlling water erosion, and overcoming droughtiness of the Vang soil are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface and installing grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to conserve moisture, maintain tilth, and provide food and cover for resident and migratory wildlife. Additions of organic material also help to maintain tilth.

The Walsh soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Vang soil is suited to some of the climatically adapted species. It is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

The Walsh soil is suited to septic tank absorption fields, but the Vang soil is poorly suited. The Walsh soil is suited and the Vang soil is well suited to buildings. The moderate permeability of the Walsh soil is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. If the tile is laid below a depth of 40 inches, however, pollution of ground water may result. Because of the rapid permeability, the Vang soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The shrink-swell potential of the Walsh soil is a limitation for buildings sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The sides of shallow excavations, such as those of basements, in both soils tend to cave in unless they are shored.

The land capability classification of the Walsh soil is IIe, and that of the Vang soil is IIIe. The productivity index of the unit for spring wheat is 75.

35—Inkster loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on outwash plains. Individual areas range from 5 acres to more than 400 acres in size.

Typically, the surface soil is black loam about 10 inches thick. The subsoil is very dark grayish brown fine sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is very dark grayish brown. It is sandy loam in the upper part and loamy sand in the lower part. In some places the surface soil is sandy loam. In other places the subsoil and substratum are loam. In a few areas the substratum is gravelly sand below a depth of 40 inches.

Included with this soil in mapping are small areas of the well drained Brantford soils and somewhat excessively drained Binford soils on low ridges. These soils make up 5 to 15 percent of the individual mapped areas. Binford and Brantford soils have a sand and gravel substratum.

Permeability is moderately rapid in the Inkster soil. Runoff is slow. Available water capacity is moderate. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Overcoming droughtiness and maintaining tilth are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface helps to conserve soil moisture, maintain tilth, and control localized erosion. Rye or winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and is well suited to building sites. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIe. The

productivity index for spring wheat is 70.

36B—Maddock loamy fine sand, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on flats and on rises on delta plains. Individual areas range from 10 acres to more than 250 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 8 inches thick. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark brown loamy fine sand in the upper part, dark brown fine sand in the next part, and grayish brown fine sand in the lower part. In some places the soil is coarse sand throughout. In other places the substratum is shaly sand and gravel.

Included with this soil in mapping are small areas of the moderately well drained Inkster soils. These soils make up about 5 to 15 percent of the individual mapped areas. Inkster soils have more clay and shaly sand throughout than does the Maddock soil. They occur as areas intermingled with areas of the Maddock soil.

Permeability is rapid in the Maddock soil. Runoff is slow. Available water capacity is low. Tilth is good. The organic matter content is moderately low.

Most areas of this soil are used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. The hazard of water erosion is slight, and that of soil blowing is severe. Overcoming droughtiness and controlling soil blowing are the main management concerns if cultivated crops are grown. Soil blowing can be overcome by applying a conservation tillage system that includes leaving crop residue on the surface, providing field windbreaks, including grasses and legumes in the cropping system, and providing annual buffer strips. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

The Maddock soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soil is somewhat droughty, and trees and shrubs commonly are affected by moisture stress, particularly during the establishment period. Irrigation or supplemental watering during the establishment period helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil is poorly suited to septic tank absorption fields and is well suited to buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 40.

36E—Maddock loamy fine sand, 9 to 35 percent slopes. This deep, strongly sloping to steep, well drained soil is on side slopes on dissected delta plains. Individual areas range from 20 acres to more than 200 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 8 inches thick. The subsoil is very dark grayish brown loamy fine sandy about 5 inches thick. The substratum to a depth of about 60 inches is dark brown loamy fine sand in the upper part, dark brown fine sand in the next part, and grayish brown fine sand in the lower part. In some places the substratum is silty clay loam below a depth of 40 inches. In other places the soil has a loamy fine sand subsurface layer.

Included with this soil in mapping are small areas of excessively drained soils interspersed with areas of the Maddock soil. They make up about 5 to 10 percent of the individual mapped areas.

Permeability is rapid in the Maddock soil. Runoff is medium. Available water capacity is low. The organic matter content is moderately low.

Most areas of this soil are used as woodland wildlife habitat or woodland pasture. Because of the slope and a severe hazard of soil blowing, the soil generally is unsuited to cultivated crops and hay. It is best suited to woodland wildlife habitat or woodland pasture. A planned grazing system helps to protect the soil from erosion and to maintain or improve the vigor of the important pasture plants. It also helps to maintain plant cover for woodland wildlife and permits regrowth of browse plants.

This soil is poorly suited to septic tank absorption fields and buildings. Because of the rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground

water. Using a mound system helps to prevent this pollution. The slope is a limitation for building sites and septic tank absorption fields. It can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is VIIe. The productivity index for spring wheat is 0.

37—Arveson loam. This deep, level, poorly drained, highly calcareous soil is on flats on delta plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The next layer is dark gray, mottled fine sandy loam about 5 inches thick. The subsoil is grayish brown, mottled fine sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled fine sandy loam in the upper part and light brownish gray, mottled loamy sand in the lower part. In some places the soil is slightly saline or moderately saline. In other places the soil is very fine sandy loam or silt loam throughout.

Included with this soil in mapping are small areas of the Colvin soils. These soils make up about 5 to 15 percent of the individual mapped areas. Colvin soils are silty clay loam throughout. They occur as areas intermingled with areas of the Arveson soil.

Permeability is moderately rapid in the Arveson soil. Runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 1 to 2 feet. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface, providing annual buffer strips, and providing field windbreaks help to control soil blowing. Conservation tillage also helps to maintain tilth and provides food and cover for resident and migratory wildlife.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the poor filtering capacity. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 35 to 65, depending on the degree of drainage.

38—Hegne silty clay. This deep, level, poorly drained, highly calcareous soil is on flats on lacustrine plains. Individual areas range from 20 acres to more than 600 acres in size.

Typically, the surface soil is black silty clay about 11 inches thick. The subsoil is silty clay about 25 inches thick. It is dark gray in the upper part and gray and mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay. In some places the soil is slightly saline or moderately saline. In other places it has a noncalcareous subsoil. In a few areas a thin layer of gravel and cobblestones is on the surface.

Included with this soil in mapping are small areas of the strongly saline Hegne soils. These soils make up about 5 to 15 percent of the individual mapped areas. They are adjacent to drains and ditches.

Permeability is very slow in the Hegne soil. Runoff is slow. Available water capacity is moderate. A seasonal high water table is at a depth of 1.0 to 2.5 feet. Tilth is poor. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Overcoming wetness, controlling soil blowing, and maintaining or improving tilth are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. The best time for tillage is when the soil is neither too wet nor too dry. The surface tends to puddle when wet and become cloddy when dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface, providing annual buffer strips, and providing field windbreaks help to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are

unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slow permeability, wetness, and the high shrink-swell potential. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat is 75.

39—Hegne silty clay, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is on flats on lacustrine plains. Individual areas range from 70 acres to more than 500 acres in size.

Typically, the surface soil is black silty clay about 11 inches thick. It contains masses of salt. The subsoil is silty clay about 34 inches thick. It is dark gray in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay. In some places the soil is slightly saline or strongly saline. In other places it has a noncalcareous subsoil.

Included with this soil in mapping are small areas of the nonsaline Hegne soils. These soils make up 5 to 15 percent of the individual mapped areas. They occur as areas intermingled with areas of the saline Hegne soil.

Permeability is very slow in this Hegne soil. Runoff is ponded. Available water capacity is low. The salts in the soil reduce the amount of water available to plants. A seasonal high water table is 1.0 foot above to 2.5 feet below the surface. Tilth is poor. The organic matter content is high.

Most areas of this soil are used for pasture or hay. Some areas are used for cultivated crops. Because of salinity and wetness, the soil is poorly suited to small grain, sunflowers, and flax. It is best suited to pasture and hay. The hazard of soil blowing is moderate, and that of water erosion is slight. Western wheatgrass, tall wheatgrass, and sweetclover are suitable pasture and hay plants. Soil blowing is a hazard, especially if the pasture is overgrazed. It can be overcome by maintaining an adequate cover of the suitable pasture and hay plants.

The Hegne soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited amount of available water because of the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slow permeability, the ponding, and the high shrink-swell potential. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat is 35.

40—Glyndon silt loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats and low rises on lacustrine plains. Individual areas range from 10 acres to more than 150 acres in size.

Typically, the surface soil is about 15 inches thick. It is black. It is silt loam in the upper part and very fine sandy loam in the lower part. The subsoil is grayish brown, mottled very fine sandy loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loamy very fine sand. In some places the surface soil is silt loam. In other places the surface soil and substratum are very fine sandy loam or fine sandy loam.

Included with this soil in mapping are small areas of the poorly drained Arveson soils. These soils make up about 5 to 15 percent of the individual mapped areas. Arveson soils have a mottled subsoil. They are in shallow depressions.

Permeability is moderately rapid in the Glyndon soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good. The organic matter content is high.

Most areas of this soil are used for cultivated crops. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface, providing annual buffer strips, and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and

environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is poorly suited to septic tank absorption fields and is suited to buildings. The seasonal high water table is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The seasonal high water table is a limitation for building sites with basements, but it can be overcome by installing a surface and foundation drainage system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIe. The productivity index for spring wheat is 85.

41—Kelvin loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on till plains. Individual areas range from 10 acres to more than 150 acres in size.

Typically, the surface layer is dark gray loam about 7 inches thick. The subsoil is dark grayish brown clay about 41 inches thick. It is mottled between depths of 28 and 48 inches. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places the surface layer is silty clay loam or clay loam. In other places the dark color of the surface layer extends to a depth of 8 inches or more.

Included with this soil in mapping are small areas of the poorly drained Tonka soils, well drained Cresbard soils, and somewhat poorly drained Suomi soils. These soils make up about 5 to 15 percent of the individual mapped areas. Cresbard soils have an alkali subsoil. They occur as areas intermingled with areas of the Suomi soil. Suomi soils have a mottled subsoil. They are in swales. Tonka soils have a mottled subsurface layer. They are in depressions.

Permeability is moderately slow in the Kelvin soil. Runoff is slow. Available water capacity is high. Tilth is good. The organic matter content is moderate.

Most areas of this soil are used for cultivated crops. A few areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Maintaining soil tilth is the main management concern if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control localized soil erosion and maintain tilth. It also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is poorly suited to septic tank absorption fields and is suited to buildings. The moderately slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

The land capability classification is IIc. The productivity index for spring wheat is 85.

42—Suomi-Kelvin complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on till plains. The somewhat poorly drained Suomi soil is in swales. The well drained Kelvin soil is on rises. Individual areas range from 15 acres to more than 1,000 acres in size. They are 40 to 55 percent Suomi soil and 25 to 40 percent Kelvin soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Suomi soil is very dark gray silty clay loam about 6 inches thick. The subsurface layer is dark gray silt loam about 3 inches thick. The subsoil is about 22 inches thick. It is very dark grayish brown clay in the upper part; very dark grayish brown, mottled clay in the next part; and dark grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In places the surface layer is loam.

Typically, the surface layer of the Kelvin soil is dark gray loam about 7 inches thick. The subsoil is clay loam about 41 inches thick. It is dark grayish brown in the upper part and light olive brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In places the dark color of the surface layer extends to a depth of 8 inches or more.

Included with these soils in mapping are small areas of the poorly drained Tonka soils and moderately well drained Cresbard soils. These included soils make up about 5 to 20 percent of the individual mapped areas. Tonka soils have a mottled subsurface layer. They are

in depressions. Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Suomi soil.

Permeability is slow in the Suomi soil and moderately slow in the Kelvin soil. Runoff is slow on both soils. Available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet in the Suomi soil. Tilth is fair in both soils. The organic matter content is moderate in both soils.

Most areas of these soils are used for cultivated crops. A few areas are used as woodland. The soils are suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Overcoming wetness in the Suomi soil and maintaining tilth are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface helps to maintain tilth and control localized soil erosion.

The Suomi soil is suited to all and the Kelvin soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

The Kelvin soil is suited to septic tank absorption fields, but the Suomi soil is poorly suited. Both soils are suited to buildings. The moderately slow and slow permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table in the Suomi soil is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The drainage also helps to prevent seepage into basements in the Suomi soil.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 80.

44—Waukon loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on till plains. Individual areas range from 10 acres to more than 75 acres in size.

Typically, a 1-inch cover of partially decayed leaves, twigs, and roots is at the surface. The surface layer is black loam about 3 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The next layer is very dark grayish brown loam about 4 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the surface layer is dark gray. In other places the dark color of the surface layer extends to a depth of 7 inches or more. In a few areas the soil contains more clay throughout.

Included with this soil in mapping are small areas of the poorly drained Tonka soils and moderately well drained Cresbard soils. These soils make up about 5 to 15 percent of the individual mapped areas. Tonka soils have a mottled subsurface layer. They are in depressions. Cresbard soils have a dense, alkali subsoil. They are in drainageways.

Permeability is moderate in the Waukon soil. Runoff is slow. Available water capacity is high. Tilth is good. The organic matter content is moderate.

Most areas of this soil are used for cultivated crops. A few areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Maintaining tilth is the main management concern if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control localized soil erosion and maintain tilth. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields and well suited to buildings. The moderate permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IIc. The productivity index for spring wheat is 85.

44B—Waukon loam, 3 to 6 percent slopes. This deep, undulating, well drained soil is on side slopes on dissected till plains. Individual areas range from 5 acres to more than 40 acres in size.

Typically, a 1-inch cover of partially decayed leaves, twigs, and roots is at the surface. The surface layer is black loam about 3 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The next layer is very dark grayish brown loam about 4 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and very dark

grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the surface layer is light gray. In other places the soil contains more clay throughout. In some areas the dark color of the surface layer extends to a depth of 7 inches or more.

Included with this soil in mapping are small areas of the moderately well drained Cresbard soils and well drained Buse and Vang soils. These soils make up about 5 to 15 percent of the individual mapped areas. Cresbard soils have a dense, alkali subsoil. They are in swales. Buse and Vang soils are on shoulder slopes. Buse soils have a calcareous subsoil. Vang soils have a gravelly substratum.

Permeability is moderate in the Waukon soil. Runoff is medium. Available water capacity is high. Tilth is good. The organic matter content is moderate.

Most areas of this soil are used for cultivated crops. A few areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Maintaining tilth and controlling water erosion are the main management concerns if cultivated crops are grown. Applying a conservation tillage system that includes leaving crop residue on the surface and installing grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to maintain tilth and provides food and cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields and is well suited to buildings. The moderate permeability is a limitation for septic tank absorption fields, but it can be overcome by enlarging the absorption field.

The land capability classification is IIe. The productivity index for spring wheat is 80.

44C—Waukon loam, 6 to 9 percent slopes. This deep, moderately sloping, well drained soil is on side slopes on dissected till plains. Individual areas range from 5 acres to more than 20 acres in size.

Typically, a 1-inch cover of partially decayed leaves, twigs, and roots is at the surface. The surface layer is black loam about 3 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The next layer is very dark grayish brown loam about 4 inches thick. The subsoil is clay loam about 27 inches thick. It is dark grayish brown in the upper part and very dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the surface layer is light gray. In other places the soil contains more clay throughout. In some areas the dark color of the surface layer extends to a depth of 7 inches or more.

Included with this soil in mapping are small areas of the well drained Buse and Edgeley soils on shoulder slopes. These soils make up about 5 to 15 percent of the individual mapped areas. Buse soils have a calcareous subsoil. Edgeley soils are moderately deep.

Permeability is moderate in the Waukon soil. Runoff is rapid. Available water capacity is high. Tilth is good. The organic matter content is moderate.

Most areas of this soil are used for cultivated crops. A few areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazard of water erosion is severe, and that of soil blowing is slight. Controlling erosion is the main management concern if cultivated crops are grown. Water erosion can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface and by installing grassed waterways in areas where runoff concentrates. Conservation tillage also helps to maintain tilth and provides food and cover for resident and migratory wildlife.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

This soil is suited to septic tank absorption fields and is well suited to buildings. The moderately slow permeability, a limitation for septic tank absorption fields, can be overcome by enlarging the absorption field.

The land capability classification is IIIe. The productivity index for spring wheat is 60.

46F—Olga-Kloten complex, 9 to 120 percent slopes. These well drained soils are in valleys and on dissected till plains. The deep, strongly sloping to steep Olga soil is on side slopes and foot slopes. The shallow, strongly sloping to very steep Kloten soil is on shoulder slopes. Soil slippage and slumping are common. Shale is exposed on some cutbanks and in slump areas. Individual areas range from 50 acres to more than 2,000 acres in size. They are 40 to 60 percent Olga soil and 30 to 60 percent Kloten soil. The

two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, about 1-inch of partially decayed leaves, grass, and roots is at the surface of the Olga soil. The surface layer is black silty clay loam about 7 inches thick. The subsurface layer is dark gray silty clay loam about 5 inches thick. The subsoil is very dark grayish brown silty clay about 18 inches thick. The upper part of the substratum is dark grayish brown clay loam, and the lower part to a depth of about 60 inches is dark gray clay. In some places the surface layer is dark gray. In other places the soil does not have a subsurface layer and subsoil and the surface layer is silty clay. In a few areas the soil contains less clay throughout.

Typically, the surface layer of the Kloten soil is very dark gray loam about 4 inches thick. The next layer is very dark grayish brown channery loam about 12 inches thick. Below this is shale. In some places the shale is fractured and contorted as a result of slumping. In other places the depth to shale is 20 to 40 inches. In a few areas the surface layer is light gray.

Included with these soils in mapping are small areas of very poorly drained organic soils, moderately well drained Fairdale soils, well drained Buse soils, and excessively drained Coe soils. These soils make up about 10 to 20 percent of the individual mapped areas. The organic soils are in swales. The Fairdale soils do not have a subsoil and have fine stratification below the surface layer. They are on narrow flood plains. The Buse soils have a calcareous subsoil. They are on shoulder slopes above the Kloten soil. Coe soils have a gravelly substratum. They occur as areas intermingled with areas of the Kloten soil.

Permeability is slow in the Olga soil and moderate in the Kloten soil. Runoff is rapid on both soils. Available water capacity is high in the Olga soil and very low in the Kloten soil. Shale restricts the rooting depth in the Kloten soil. The organic matter content is moderate in the Olga soil and high in the Kloten soil.

Most areas of these soils are used for woodland wildlife habitat or woodland pasture. Because of the slope and the severe hazard of water erosion, these soils generally are unsuited to cultivated crops and hay. They are best suited to woodland wildlife habitat or woodland pasture. When the soils are used for woodland pasture, using a planned grazing system helps to protect the soils from erosion and to maintain or improve the important pasture plants. It also helps to maintain plant cover for woodland wildlife and permits regrowth of browse plants. Bur oak is the dominant species of tree. The understory is beaked hazel and serviceberry. These species provide excellent cover and food for wildlife.

These soils generally are unsuited to septic tank absorption fields and buildings because of the slope, depth to bedrock, and the soil slippage and slumping.

The land capability classification of both soils is VIIe. The productivity index of the unit for spring wheat is 0.

48—Cashel silty clay. This deep, level, somewhat poorly drained soil is on flats on flood plains. It is subject to occasional flooding. Individual areas range from 10 acres to more than 100 acres in size.

Typically, the surface layer is black silty clay about 7 inches thick. The substratum to a depth of about 60 inches is mottled. In sequence downward, it is very dark grayish brown and olive silty clay, very dark gray silty clay, olive gray silty clay loam, and black silty clay. In some places the dark color of the surface layer extends to a depth of more than 8 inches. In other places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the poorly drained Hegne soils and moderately well drained Fairdale soils. These soils make up about 5 to 10 percent of the individual mapped areas. Hegne soils have a subsoil that has an accumulation of lime within 16 inches of the surface. They are in swales. Fairdale soils contain less clay throughout than does the Cashel soil. They are adjacent to the stream channel.

Permeability is slow in the Cashel soil. Runoff is slow. Available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. Tilth is poor. The organic matter content is high.

Most areas of this soil are used for cultivated crops. A few areas are used as woodland. The soil is suited to small grain, sunflowers, and flax. The hazard of soil blowing is moderate, and that of water erosion is slight. Maintaining tilth and controlling soil blowing are the main management concerns if cultivated crops are grown. Seeding may be delayed in some years because of flooding. The best time for tillage is when the soil is neither too wet nor too dry. Timely tillage helps to improve tilth. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control soil blowing and maintain tilth. Conservation tillage also provides food and cover for resident and migratory wildlife.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of

this ground cover improves the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and is only suited to buildings because of the flooding. Better sites generally are nearby.

The land capability classification is IIe. The productivity index for spring wheat is 85.

49C—Fordville-Sioux complex, 3 to 9 percent slopes. These deep, gently sloping and moderately sloping soils are on outwash plains and on eskers on glacial till plains. The well drained Fordville soil is in swales. The excessively drained Sioux soil is on ridges. Individual areas range from 5 acres to more than 50 acres in size. They are 40 to 60 percent Fordville soil and 25 to 40 percent Sioux soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Fordville soil is black loam about 7 inches thick. The subsoil is loam about 20 inches thick. It is very dark grayish brown in the upper part and grayish brown in the lower part. The upper part of the substratum is light olive brown gravelly loamy sand, and the lower part to a depth of about 60 inches is olive brown gravelly sand. In some places the substratum is mostly shale gravel. In other places the subsoil extends to a depth of only 14 to 20 inches. In a few areas the substratum is very gravelly loam.

Typically, the surface layer of the Sioux soil is very dark gray gravelly loam about 7 inches thick. The next layer is dark brown gravelly loam. The substratum to a depth of about 60 inches is very gravelly sand. It is dark grayish brown and olive brown in the upper part and dark brown and dark yellowish brown in the lower part. In some places the substratum is mostly shale gravel. In other places the soil has a thin subsoil. In a few areas the surface layer is sandy loam and the substratum is fine sand.

Included with these soils in mapping are small areas of the moderately well drained Svea soils and well drained Buse soils. These included soils make up about 10 to 20 percent of the individual mapped areas. Svea and Buse soils have a nongravelly substratum. Svea soils occur as areas intermingled with areas of the Fordville soil. Buse soils occur as areas intermingled with areas of the Sioux soil.

Permeability is moderate in the upper part of the Fordville soil and rapid in the lower part. It is very rapid in the Sioux soil. Runoff is medium on both soils. Available water capacity is moderate in the Fordville soil and low in the Sioux soil. Tilth is good in both soils. The organic matter content is high in the Fordville soil and moderately low in the Sioux soil.

Most areas of these soils are used for cultivated crops. The soils are poorly suited to small grain, sunflowers, and flax. The hazard of water erosion is moderate, and that of soil blowing is slight. Controlling water erosion and overcoming droughtiness are the main management concerns if cultivated crops are grown. Water erosion can be controlled by applying a conservation tillage system that includes leaving crop residue on the surface. Rye and winter wheat are particularly well suited because they make the best use of the soil moisture available early in the season. Leaving tall stubble on the surface helps to trap snow and store soil moisture.

The Fordville soil is suited to some of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Sioux soil generally is unsuited. The Fordville soil is droughty, and trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because available water capacity is limited. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are poorly suited to septic tank absorption fields but are well suited to buildings. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity may result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the Fordville soil is IVe, and that of the Sioux soil is VIs. The productivity index of the unit for spring wheat is 40.

51—Colvin silty clay loam. This deep, level, very poorly drained, highly calcareous soil is in depressions on till plains. It is subject to ponding. Individual areas range from 10 acres to more than 50 acres in size.

Typically, a 1-inch cover of partially decayed stems, roots, and mosses is at the surface. The surface layer is black silty clay loam about 8 inches thick. The mottled subsoil is silty clay loam about 15 inches thick. It is light gray in the upper part and grayish brown in the lower part. The mottled substratum to a depth of about 60 inches is olive gray silty clay loam in the upper part,

light olive brown silty clay loam in the next part, and light olive brown clay loam in the lower part. In some places the soil does not have a subsoil. In other places the subsoil has an accumulation of clay.

Included with this soil in mapping are small areas of the poorly drained Manfred and Vallers soils surrounding the depressions. These soils make up about 5 to 15 percent of the individual mapped areas. Manfred soils have a dense, alkali subsoil. Vallers soils contain more sand and less clay throughout.

Permeability is moderately slow in the Colvin soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is 1 foot above to 1 foot below the surface. Tilth is fair. The organic matter content is high.

Most areas of this soil are used for cultivated crops, native hay, or wetland wildlife habitat. If drained, the soil is suited to small grain, sunflowers, and flax. It is best suited to native hay, range, or wetland wildlife habitat. The hazard of soil blowing is moderate, and that of water erosion is slight. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. Providing surface drainage and delaying tillage and planting help to reduce wetness. Applying a conservation tillage system that includes leaving crop residue on the surface helps to control erosion and provide food and cover for resident and migratory wildlife. Where the soil is undrained, crops are planted and harvested in only about 3 to 5 years out of 10. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural wetness and controlling sedimentation.

The important native forage plants are slough sedge and rivergrass. Compaction, trampling, and root shearing are problems, especially if the range is grazed when the soil is wet. They can be overcome by deferring grazing while the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 20 to 70, depending on the degree of drainage. The range site is Wetland.

53—Hamar loamy fine sand. This deep, level, poorly drained soil is in swales on delta plains. Individual areas range from 5 acres to more than 50 acres in size.

Typically, the surface soil is very dark grayish brown loamy fine sand about 11 inches thick. It is mottled between depths of 6 and 11 inches. The next layer is very dark grayish brown, mottled loamy fine sand about 8 inches thick. The substratum extends to a depth of about 60 inches. It is mottled. It is dark grayish brown loamy fine sand in the upper part and olive brown fine sand in the lower part. In some places the soil is fine sandy loam throughout. In other places the soil has a highly calcareous subsoil.

Included with this soil in mapping are small areas of the Maddock soils. These soils make up about 5 to 15 percent of the individual mapped areas. Maddock soils are not mottled. They are on rises.

Permeability is rapid in the Hamar soil. Runoff is slow. Available water capacity is low. A seasonal high water table is at a depth of 0.5 to 2.0 feet. Tilth is good. The organic matter content is moderately low.

Most areas of this soil are used for cultivated crops. The soil is poorly suited to small grain, sunflowers, and flax. The hazard of soil blowing is severe, and that of water erosion is slight. Overcoming wetness and controlling soil blowing are the main management concerns if cultivated crops are grown. Wetness can be overcome by delaying tillage and planting. Applying a conservation tillage system that includes leaving crop residue on the surface, providing annual buffer strips, and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to these uses. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings. Strips of an annual cover crop between the rows of trees and

shrubs help to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to septic tank absorption fields and buildings because of the wetness and the poor filtering capacity. Better sites generally are nearby.

The land capability classification is IVw. The productivity index for spring wheat is 25 to 50, depending on the degree of drainage.

55—Roliss silt loam. This deep, level, very poorly drained soil is in deep depressions on glacial till plains. It is subject to ponding. Most areas are drained. Individual areas range from 4 acres to more than 500 acres in size.

Typically, the surface soil is black silt loam about 19 inches thick. The subsoil is olive gray, mottled clay loam about 14 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled loam. In some places the subsoil is highly calcareous. In other places the dark color of the surface soil extends to a depth of more than 24 inches. In a few areas the surface soil is peat or mucky peat.

Included with this soil in mapping are small areas of poorly drained Manfred and Vallers soils surrounding the depressions. These soils make up 5 to 15 percent of the individual mapped areas. Manfred soils have a dense, alkali subsoil. Vallers soils have a subsoil that has an accumulation of lime within 16 inches of the surface.

Permeability is moderately slow in the Roliss soil. Runoff is ponded. Available water capacity is high. A seasonal high water table is at 0.5 foot above to 3 feet below the surface. Tilth is good. The organic matter content is very high.

Most areas of this soil are used for cultivated crops. If drained, the soil is suited to small grain, sunflowers, and flax. The hazards of soil blowing and water erosion are slight. Overcoming wetness is the main management concern if cultivated crops are grown. It can be overcome by constructing a surface drainage system and delaying tillage and planting. Where the soil is drained and cultivated, applying a conservation tillage system that includes leaving crop residue on the surface helps to control localized soil erosion and provides food and cover for resident and migratory wildlife.

Drained areas of this soil are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited to trees and shrubs. The wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of the cover improves the survival and growth rates of the seedlings.

This soil generally is unsuited to septic tank absorption fields and buildings because of the slow permeability and the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 20 to 70, depending on the degree of drainage.

57—Pits. This unit consists of areas from which the soil has been removed to mine the underlying sand and gravel or shale. The pits are irregularly shaped. Most areas are barren of vegetation. Some areas are filled with water. Individual areas range from 3 acres to more than 25 acres in size.

This unit generally is unsuited to cultivated crops and to trees and shrubs unless the areas are leveled, topdressed with suitable topsoil, and otherwise reclaimed. Onsite investigation is needed to determine whether an area is suited to building site development, septic tank absorption fields, and other uses.

The land capability classification is VIIIe.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable

supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 563,780 acres in the county, or about 58 percent of the total acreage, meets the soil requirements for prime farmland. The prime farmland in Cavalier County is mainly in associations 3, 4, 5, 6, 7, 9, and 10, which are described in the section "General Soil Map Units." More than 90 percent of this prime farmland is used for crops. The crops grown on this land, mainly barley, spring wheat, and durum, account for an estimated 75 percent of the county's total agricultural income each year.

The map units in the survey area that are considered to be prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name at the end of this section. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

6	La Prairie loam
8	Lamoure silt loam (where drained)
10	Svea-Barnes loams, 0 to 3 percent slopes
10B	Svea-Barnes loams, 3 to 6 percent slopes
11B	Svea-Buse loams, 3 to 6 percent slopes
12B	Barnes-Buse loams, 3 to 6 percent slopes
14	Divide loam, 1 to 3 percent slopes
15	Wyard-Hamerly loams, 0 to 3 percent slopes (where drained)
16	Hamerly-Tonka loams, 0 to 3 percent slopes (where drained)
25	Hattie clay, 1 to 3 percent slopes
26	Rolette clay loam, 1 to 3 percent slopes
26B	Rolette clay loam, 3 to 6 percent slopes
33	Vang loam, 0 to 3 percent slopes
34	Walsh-Vang loams, 0 to 3 percent slopes
34B	Walsh, sand substratum-Vang loams, 3 to 6 percent slopes
35	Inkster loam, 0 to 3 percent slopes
37	Arveson loam (where drained)
38	Hegne silty clay (where drained)
40	Glyndon silt loam
41	Kelvin loam, 0 to 3 percent slopes
42	Suomi-Kelvin complex, 0 to 3 percent slopes
44	Waukon loam, 0 to 3 percent slopes
44B	Waukon loam, 3 to 6 percent slopes
48	Cashel silty clay

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

By Lyle Samson, agronomist, and Willis A. Pederson, soil conservationist, Soil Conservation Service

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 82 percent of Cavalier County is cultivated. In 1985, 618,700 acres was used for close-growing crops, 37,200 acres for row crops, and 9,900 acres for forage crops *(11)*. During the period 1980 to 1984, the acreage used for close-growing crops averaged 557,600 per year. The acreage of summer fallow was 235,000 in 1983, 200,000 in 1984, and 180,000 in 1985. The acreage used for sunflower production is decreasing. It averaged 47,000 acres per year from 1980 to 1984. It was 50,000 acres in 1984 and 36,500 acres in 1985. The acreage used for corn and forage has been stable in recent years. In 1985 the acreages of the principal close-growing crops were as follows: spring wheat, 200,000 acres; durum wheat, 125,000 areas; winter wheat, 5,000 acres; barley, 210,000 acres; oats, 3,500 acres; rye, 200 acres; and flax, 25,000 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 36,500 acres and corn on 700 acres. Alfalfa was grown on 2,400 acres and other hay crops on 7,500 acres. Small acreages were planted to mustard, buckwheat, sorghum, millet, and safflower.

The potential of the soils in Cavalier County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that commonly are grown in the survey area. Crops that commonly are not grown, but

are suitable, include lentils, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper use of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all adversely affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil material becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on some of the soils in Cavalier County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arveson, Binford, and Maddock soils.

Colvin, Divide, Easby, Glyndon, Hamerly, Hegne, and Vallers soils have a relatively high content of lime and are susceptible to soil blowing in spring if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down; this results in formation of aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as those of the Buse, Edgeley, Kloten, Olga, Svea, and Walsh series. It also is a severe hazard on Rolette and other soils with slopes that are gentle but long. The risk of erosion is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover on the surface. Examples are conservation tillage systems that keep a protective amount of crop residue on the surface. Applications of herbicides can help to eliminate the need for summer fallow tillage. Cover crops are also effective in controlling both soil blowing and water erosion. Field windbreaks, annual wind barriers, and stripcropping help to control soil blowing. Including grasses and legumes in the cropping system, using grassed waterways, diversions, and terraces, contour farming, and field stripcropping across the slope help to control water erosion. A management system that includes several measures is the best means of protecting the soils. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of crops during the growing season. In years when the amount of available soil moisture is low at planting time, crop success is greatly reduced. Measures that reduce evaporation and runoff rates, improve the rate of water infiltration, and control weeds help to conserve moisture. Examples are stubble mulch tillage; no-till farming; stripcropping; growing cover crops; managing crop residue; letting stubble stand; providing annual wind barriers, which trap snow; and applying fertilizer. When fallow is used to conserve moisture for the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applying commercial fertilizer, growing green manure crops, including legumes in the cropping system, and using barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the soils that have a surface layer of silty clay loam, clay loam, or silty clay. Cashel, Colvin, Easby, Hattie, Hegne, Manfred, Olga, Rolette, and Vallers soils are examples. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases susceptibility to erosion.

Management of Saline and Alkali Soils

Saline and alkali soils make up about 20 percent of Cavalier County. Saline soils make up about 10 percent of the county, or about 94,050 acres; alkali soils make up about 9 percent, or about 87,350 acres; and saline-alkali soils make up less than 1 percent, or about 5,220 acres.

Saline soils have a high concentration of soluble salts. The saline soils in Cavalier County are in the Easby, Hamerly, Hegne, and Vallers series.

Saline soils generally develop in areas of restricted drainage. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This buildup of salts is reduced by maintaining a surface cover of plants. The roots of the plants use the soil water before it can reach the surface and before the salts accumulate. The surface cover reduces evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the

surface. Saline soils, such as the Hamerly and Vallers soils, generally form in areas adjacent to natural sloughs and waterways.

Plants growing on saline soils absorb salts from the soil water. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts generally are not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts commonly are visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the amount of salts in the soils. For instance, small grain growing on saline soils tends to be stunted and has fewer tillers than does small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can produce salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they are established.

Alkali soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soil. The alkali soils in Cavalier County are those of the Cavour and Cresbard series. Locally, alkali soils are known as "black-alkali," "slick spots," "pan spots," or "gumbo."

Alkali soils develop in a complex pattern with a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the alkali soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10.

Alkali soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, as the water table lowers, rain gradually leaches the salts from the surface to lower horizons. During this leaching process, the clay in the soil becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, alkali subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Examples of soils that have a dense, alkali subsoil are those of the Cavour and Mekinock series.

As the leaching by soil water continues, the sodium is gradually moved lower in the soil profile and eventually is carried below the rooting depth. The result is a more manageable soil, such as that of the Cresbard series. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonalkali soil. This change requires a long period, usually centuries *(5)*.

If plowed, alkali soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils are unfavorable for plant growth. The harmful effects generally increase as the sodium content increases. As the sodium content increases, the amount of water available to plants is reduced; the effect of this is more harmful than the toxic effect of the sodium. The plants also are affected by the depth to the dense subsoil.

Identification of alkali soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of soil moisture stress, is a useful indicator of the level of alkalinity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of alkalinity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effect of alkalinity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of alkali soils can cause management problems. The alkali soils that have salts within a depth of 16 inches, such as those of the Mekinock and Miranda series, generally are best suited to native grasses. The soils that have a dense, alkali subsoil near the surface generally are unsuited to small grain and sunflowers.

Timely tillage is an important management need in areas of leached alkali soils, such as those of the Cresbard series. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when they are too dry, tillage and seeding implements cannot easily penetrate them. Deep plowing and applying chemical amendments can help to reclaim alkali soils, but these practices may not be feasible. To be effective, deep tillage should reach to the alkali subsoil and mix several inches of the

underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of alkali soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-alkali soils develop in areas of restricted drainage where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, alkali subsoil has formed. The saline-alkali soils in Cavalier County are those of the Manfred, Mekinock, and Miranda series. The management needs and crop responses on these soils are a combination of those on saline soils and those on alkali soils.

Additional information about management or reclamation of saline and alkali soils is available from the local offices of the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the Cooperative Extension Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management or as otherwise stated are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison with other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In Cavalier County a productivity index of 100 was considered equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. Svea-Barnes loams, 0 to 3 percent slopes, for example, has a productivity index of 90 that, when multiplied by 40 and then divided by 100, converts to 36, which is the expected annual yield of spring wheat in bushels per acre for this map unit (see table 5).

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(16)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce

the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

By Roy S. Mann, range conservationist, Soil Conservation Service

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1986 approximately 58,000 acres in Cavalier County, or about 6 percent of the total acreage, was rangeland. In areas where it is properly managed, this rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on rolling to very steep, loamy, dissected till plains and on level till plains. Most of the rangeland is in areas of level, very poorly drained soils and rolling to very steep, well drained soils. The soils generally are unsuited or at best poorly suited to cultivated crops.

In 1985 the farms and ranches in the county had about 9,000 head of cattle. Of that number, about 300 were milk cows *(11)*.

Because of the relatively short growing season, some farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in spring and fall. Generally, large amounts of hay and feed are needed because of the long winters. Hay was harvested on about 9,900 acres in 1985 *(11)*.

Range Sites and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable, and its composition indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kinds of plants that grew when the region was settled. The climax vegetation generally is the most productive combination of forage plants that can be grown on the site. When the site is improperly grazed, some of the climax vegetation decreases in proportion and some of it increases. Also, other plants that were not part of the native plant community invade the site.

Decreaser plants are the species that decline in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the

decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy, continual grazing. Most invader species have little grazing value.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community resembles the natural plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all the soils in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, stage of growth, exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are maintained or improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and thus can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the climax decreaser species have not been completely grazed out. If overgrazing is stopped, enough climax vegetation generally remains for proper grazing use, deferred grazing, and a planned grazing system to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species also can restore productive rangeland in areas of poor-quality cropland. Brush control, development of watering facilities, and other practices are needed to improve the potential of some

rangeland. Good management is one of the most overlooked means of improving rangeland. Proper fencing provides the opportunity to achieve good management.

The following paragraphs describe the range sites in Cavalier County. The names of these sites are Claypan, Overflow, Saline Lowland, Shallow, Silty, Thin Claypan, Thin Upland, and Wetland.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. Fringed sagewort is a common shrub on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, broom snakeweed, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing the vegetation is difficult in bare areas. Careful management that maintains the abundance of the naturally dominant plants is the best way to maintain forage production and protect the soil from water erosion.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, grow on the site, depending on the position on the landscape. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in a dominance of blue grama, sedges, Kentucky bluegrass, and unpalatable forbs.

Because of its position on the landscape, this site is frequently overgrazed. Separate fencing of this site generally is not feasible because of the small size or the shape of areas of this site. As a result of flooding and the runoff received by these areas, this site is very productive when properly managed. Using a planned grazing system can restore the site and maintain a high level of productivity. Reseeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, and other salt-tolerant species, including western wheatgrass and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and restricted available water capacity limit forage production on this site. Careful management of the adapted, desirable salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in bare areas. Livestock watering ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Shallow range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, and green needlegrass. Other species are plains muhly, blue grama, porcupinegrass, threadleaf sedge, and Pennsylvania sedge. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green

needlegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are blue grama, western wheatgrass, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, unpalatable forbs, and fringed sagewort.

Because of limited available water capacity, forage production is limited on this site. It varies, depending on the rainfall pattern. The site is fragile, and the plant community can deteriorate rapidly if poor management results in severe erosion. Management that keeps the plant community near its potential helps to control erosion and results in the best use of available water.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of weedy species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, Kentucky bluegrass, and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect the management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Livestock watering pits should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site is denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, red threeawn, and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect the management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Soil blowing is a problem in bare areas. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in soil compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. Using a planned grazing system and deferring grazing when the site is wet help to maintain the climax vegetation and the wetland wildlife habitat.

Woodland, Windbreaks, and Environmental Plantings

By Bruce C. Wight, forester, Soil Conservation Service

Cavalier County has approximately 45,000 acres of native woodland *(9)*. Most of this woodland is in the area known as the Pembina Hills, which includes the valleys of the Pembina, Little South Pembina, and Little North Pembina Rivers and their tributaries. Woodland also occurs along the Park and Tongue Rivers, in the southeastern part of the county. Trees and shrubs occur on the fringe of wetlands on the till plain in the southwestern part of the county. The woodland on the side slopes of the river valleys is primarily in areas of Rolette clay loam, Olga silty clay loam, Kloten loam, Waukon loam, and Kelvin loam. Woodland in the woody draws in the upper reaches of the valleys is primarily in areas of Buse loam, Kloten loam, Walsh loam, and Edgeley loam. The woodland on bottom lands is mostly in areas of Fairdale loam and La Prairie loam. The woodland on the fringe of the wetlands on the till plain is mostly in areas of Colvin silty clay loam, Vallers loam, Hamerly loam, and Tonka loam.

The bottom land forest type is primarily American elm, green ash, American basswood, and various willow species. Other less common species include boxelder, cottonwood, common chokecherry, highbush cranberry, redosier dogwood, beaked hazel, and alder buckthorn.

There are three different woodland types along the side slopes of the river valleys. Bur oak is the dominant type, and quaking aspen and paper birch types occur to a lesser degree. Quaking aspen clumps are scattered among the oak. The lack of fire appears to be allowing a conversion from quaking aspen to bur oak. The paper birch is restricted to steep, mainly northeast-facing slopes. Other trees and shrubs associated with these major tree species include green ash, balsam poplar, beaked hazel, American hazel, chokecherry, juneberry, highbush cranberry, downy arrowwood, Woods rose, snowberry, serviceberry, alder buckthorn, red raspberry, and redosier dogwood. The shrubs are dominant in the upper reaches of the river valleys, in troughs between slump ridges, and in areas cleared of trees by beaver or fire.

The word "pembina" is the Ojibwa Indian name for highbush cranberry, the species that gives the Pembina River its name and that provides colorful foliage in fall *(12)*.

The principal species in the woodland fringe of the wetlands in the county are quaking aspen, various willows, and redosier dogwood.

Early settlers used the trees for fuel, lumber, and fenceposts. Currently, there is renewed interest in using trees for fuel. The principal uses of trees, however, are for protection from wind and esthetic purposes. The trees protect the soils, homes, livestock, wildlife, and watersheds from wind.

Windbreaks have been planted in Cavalier County since the early days of settlement. Most of the early plantings were made to protect farmsteads and livestock. In the 1930's about 260 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service.

Since the 1930's more than 3,700,000 trees have been planted on about 4,500 acres by county farmers and landowners with the assistance of the Soil Conservation Service and the Cavalier County Soil Conservation District. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks to help protect soils that are highly susceptible to soil blowing.

The following factors should be considered before a planting is made: (1) the purpose of the planting, (2) the suitability of the soils, (3) the adaptability of the various species of trees and shrubs, (4) the location and design of the windbreak, and (5) availability of a source of hardy and adapted trees and shrubs. If these factors are not considered, a poor or unsuccessful windbreak may result.

The successful establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the planting is made, and the regrowth of the competing ground cover should be controlled for the life of the windbreak. Some replanting of the trees and

shrubs may be necessary during the first 2 years after planting.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

By David D. Dewald, biologist, Soil Conservation Service

Cavalier County has a varied public recreational resource base. Public land includes about 5,770 acres of wildlife management areas administered by the North Dakota Game and Fish Department, about 9,620 acres of waterfowl production areas administered by the U.S. Fish and Wildlife Service, about 600 acres owned by the North Dakota Department of University and School Lands, and about 1,330 acres administered by the North Dakota Parks and Recreation Department. These public lands provide opportunities for hunting, sightseeing, hiking, horseback riding, motorbiking, snowmobiling, cross-country skiing, picnicking, berry picking, and other outdoor recreational activities.

The Pembina River Valley area is a unique recreational resource located in the survey area. The gorge created by the Pembina River has considerable relief, ranging from 1,500 feet above sea level at the western end to 950 feet above sea level near the river channel at the eastern end. This naturally wooded area lends itself to recreational development. Groomed snowmobile trails are available in the Neumadahl Hills and at Frost Fire Mountain, both located in the Pembina River Valley. The Frost Fire Mountain area also has groomed cross-country ski trails, a downhill ski area equipped with ski lifts, a golf course, and a summer theater. During periods of high streamflow, the Pembina River provides canoeing and rafting opportunities.

The Mount Carmel Dam Recreation Area provides the only camping, picnicking, and water-based recreation combination in the survey area. Seven towns located in Cavalier County have day-use picnic areas.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to

flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

By David D. Dewald, biologist, Soil Conservation Service

Wildlife habitat in Cavalier County is excellent in the wooded valleys of the Pembina, Tongue, and Park Rivers. It is poor to fair in the rest of the county as a result of intensive agriculture and extensive wetland drainage.

Wildlife populations have declined since the survey area was settled. Intensive cropping and year-long grazing of the few remaining areas of rangeland have reduced the quantity and quality of wildlife habitat.

Approximately 60 percent of the wetland acreage has been drained for agricultural use. More than 30,000 acres of woodland has been cleared. A little more than one-half of the original woodland remains.

Landowners in the county have conveyed their drainage rights on about 13,600 acres of wetlands to the Federal government under the Small Wetlands Acquisition Program. These wetlands provide breeding and rearing areas for migratory waterfowl, mainly ducks. Extensive fall burning of noneasement wetland basins destroys their value as winter cover for resident wildlife. Increased use of conservation tillage and no-till farming has provided additional food and cover. The recent introduction of no-till winter wheat has provided additional nesting sites for migratory waterfowl. In addition, private landowners are managing about 2,000 acres primarily for wildlife.

Game and nongame species in the survey area are varied. The Pembina River Valley is home to a diversified songbird population, along with ruffed grouse, moose, and elk. Bird species hunted in the survey area include Hungarian partridge, ring-necked pheasant, sharp-tailed grouse, turkeys, ducks, geese, mourning doves, and crows. Mammals hunted or trapped include white-tailed deer, moose, elk, raccoon, badger, beaver, muskrat, mink, fox, coyote, cottontail, and tree squirrels.

Approximately 15 percent of the residents of the survey area purchased a fishing license in 1984. Fishing opportunities are limited to the waters of Mount Carmel Dam. Walleye pike, northern pike, crappie, and bluegill are the species fished. The potential to develop additional fishing areas is limited.

The fish and wildlife habitat resource is an important part of the social and economic aspects of Cavalier County. It contributes significantly to the social well-being of the residents and visitors to the survey area.

Approximately 230,000 acres, or about 24 percent of Cavalier County, is designated as hydric soils. The map units in the survey area that generally display hydric conditions are listed in this section. The hydric conditions are present unless the soil has been artificially drained or otherwise altered such that it no longer supports a predominance of hydrophytic vegetation. The soil map does not identify drained areas, nor does the following list constitute a recommendation for a particular land use. Most of the wetland wildlife habitat in the county is in areas of hydric soils. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed maps at the back of this survey. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

1	Southam clay
2	Vallers, saline-Parnell complex
3	Parnell silt loam
4	Easby clay loam
5	Manfred-Vallers, saline, silty clay loams
8	Lamoure silt loam
16	Hamerly-Tonka loams, 0 to 3 percent slopes (Tonka part)
17	Vallers-Hamerly loams, saline, 0 to 3 percent slopes (Vallers part)
37	Arveson loam

38 Hegne silty clay
39 Hegne silty clay, saline
51 Colvin silty clay loam
53 Hamar loamy fine sand
55 Roliss silt loam

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, sunflowers, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate wheatgrass, tall wheatgrass, smooth bromegrass, sweetclover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are big bluestem, goldenrod, green needlegrass, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokeberry, beaked hazel, snowberry, and buffaloberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, field sparrow, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife

attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, sage grouse, western meadowlark, and savannah sparrow.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause

construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable

quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that

affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are

indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet

and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years;

and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(17)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has an udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (15)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (17)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arveson Series

The Arveson series consists of deep, poorly drained, moderately rapidly permeable, highly calcareous soils

on delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, 1,900 feet east and 200 feet north of the southwest corner of sec. 12, T. 163 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; strongly effervescent; moderately alkaline; abrupt smooth boundary.

ABk—8 to 13 inches; dark gray (10YR 4/1) fine sandy loam, gray (10YR 6/1) dry; few fine prominent olive (5Y 4/4) and dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine black (10YR 2/1) tongues; disseminated lime throughout; strongly effervescent; moderately alkaline; clear irregular boundary.

Bk—13 to 22 inches; grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; few medium prominent very dark gray (10YR 3/1) mottles and few fine prominent dark yellowish brown (10YR 4/4) and dark brown (7.5YR 3/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—22 to 43 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark brown (7.5YR 3/4) mottles and common fine prominent dark yellowish brown (10YR 4/4) mottles; massive; soft, friable, slightly sticky and slightly plastic; few fine manganese concretions; strongly effervescent; moderately alkaline; clear wavy boundary.

C2—43 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand, light gray (2.5Y 7/2) dry; many coarse prominent reddish brown (5YR 4/4) mottles and few fine prominent light olive brown (2.5Y 5/6) and very dusky red (2.5YR 2/2) mottles; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 13 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bk horizon has value of 4 or 5 (6 or 7 when dry). It is fine sandy loam or loam. The C horizon has hue of 2.5Y or 5Y. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Barnes loam in an area of Barnes-Buse loams, 3 to 6 percent slopes, 1,200 feet west and 1,250 feet south of the northeast corner of sec. 24, T. 159 N., R. 64 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few very fine roots; mildly alkaline; abrupt smooth boundary.

Bw—8 to 15 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to weak very fine subangular blocky; slightly hard, friable, sticky and slightly plastic; few very fine roots; dark brown (10YR 3/3) coatings on faces of peds; mildly alkaline; clear wavy boundary.

Bk—15 to 26 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; thin strata of sand and gravel in lower part; about 10 percent gravel; lime disseminated throughout and in common soft masses; violently effervescent; moderately alkaline; clear smooth boundary.

C—26 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light gray (2.5Y 7/2) dry; few medium prominent red (2.5YR 4/6) mottles; massive; slightly hard, friable, sticky and plastic; about 5 percent gravel; common fine threads of lime; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The Ap horizon has value of 3 or 4 when dry. The Bw horizon has value of 3 or 4 (4 to 6 when dry) and chroma of 2 to 4. It is loam or clay loam. The Bk horizon has hue of 2.5Y or 10YR, value of 4 or 6 (6 to 8 when dry), and chroma of 2 to 4. It is loam or clay loam. The C horizon has value of 4 or 5 (6 or 7 when dry) and chroma of 2 to 4. It is loam or clay loam.

Binford Series

The Binford series consists of deep, somewhat excessively drained, rapidly permeable soils on delta

plains. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 9 percent.

Typical pedon of Binford sandy loam, 1 to 9 percent slopes, 500 feet south and 130 feet east of the northwest corner of sec. 24, T. 163 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; medium acid; abrupt smooth boundary.

Bw—7 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; about 10 percent shale gravel; medium acid; abrupt smooth boundary.

2C1—14 to 24 inches; dark grayish brown (10YR 4/2) gravelly sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 20 percent shale gravel; medium acid; clear wavy boundary.

2C2—24 to 48 inches; grayish brown (10YR 5/2) gravelly coarse sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; about 15 percent shale gravel; neutral; clear wavy boundary.

2C3—48 to 60 inches; gray (10YR 6/1) sand, light gray (10YR 7/1) dry; single grain; loose, nonsticky and nonplastic; about 5 percent shale gravel; neutral.

The depth to sand and gravel ranges from 14 to 20 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has value of 3 or 4 when dry. The Bw horizon has value of 2 or 3 (4 or 5 when dry). The 2C horizon is gravelly sand, gravelly coarse sand, sand, or very coarse sand. It is 2 to 25 percent shale gravel.

Brantford Series

The Brantford series consists of deep, well drained soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 3 percent.

Typical pedon of Brantford loam, 0 to 3 percent slopes, 2,500 feet west and 950 feet north of the southeast corner of sec. 13, T. 162 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine and few fine roots; neutral; abrupt smooth boundary.

Bw—7 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent shale gravel; neutral; clear wavy boundary.

2C1—15 to 19 inches; very dark grayish brown (2.5Y 3/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 55 percent shale gravel; thin lime coatings on underside of pebbles; slightly effervescent; mildly alkaline; clear wavy boundary.

2C2—19 to 45 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; about 30 percent shale gravel; slightly effervescent; mildly alkaline; abrupt wavy boundary.

2C3—45 to 60 inches; very dark grayish brown (2.5Y 3/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; about 45 percent shale gravel; slightly effervescent; mildly alkaline.

The depth to sand and gravel ranges from 14 to 20 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has value of 3 or 4 when dry. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 when dry), and chroma of 2 or 3. It is loam or gravelly loam. The 2C horizon is 30 to 65 percent shale gravel.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 3 to 35 percent.

Typical pedon of Buse loam in an area of Barnes-Buse loams, 3 to 6 percent slopes, 990 feet west and 1,350 feet south of the northeast corner of sec. 24, T. 159 N., R. 64 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; violently effervescent; mildly alkaline; abrupt smooth boundary.

Bk—9 to 25 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; weak fine prismatic structure parting to weak very fine subangular blocky; soft, very friable, sticky and slightly plastic; few very fine roots; about 2 percent gravel; lime disseminated throughout and in few fine soft masses; violently effervescent; moderately alkaline; gradual wavy boundary.

C—25 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark brown (7.5YR 3/4) mottles; massive; slightly hard, very friable, sticky and plastic; about 5 percent gravel; few fine threads of lime; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bk horizon has value of 5 or 6 (6 to 8 when dry). It is loam or clay loam. The C horizon has value of 4 to 6 (6 or 7 when dry) and chroma of 2 to 4. It is loam or clay loam.

Cashel Series

The Cashel series consists of deep, somewhat poorly drained, slowly permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Cashel silty clay, 400 feet north and 750 feet east of the southwest corner of sec. 2, T. 163 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C—7 to 29 inches; very dark grayish brown (2.5Y 3/2) and olive (5Y 4/3) silty clay, grayish brown (2.5Y 5/2) and pale olive (5Y 6/3) dry; common fine prominent dark reddish brown (5YR 3/4) mottles; weak medium platy structure parting to moderate fine granular; hard, friable, sticky and very plastic; few fine roots; strata of silty clay loam and clay ½ to 1 inch thick; few fine soft masses of lime in the lower part; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Ab—29 to 35 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium granular structure; very hard, firm, very sticky and very plastic; few fine soft masses of lime; strongly effervescent; moderately alkaline; clear smooth boundary.

C'—35 to 47 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) and light olive brown (2.5Y 5/6) mottles; massive; hard, firm, sticky and very plastic; few fine soft masses of lime; strongly effervescent; moderately alkaline; clear smooth boundary.

A'b—47 to 60 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; few fine prominent dark reddish brown (5YR 3/4) mottles; massive; extremely hard, very firm, very sticky and very plastic; few fine soft masses of lime; strongly effervescent; mildly alkaline.

The A horizon has value of 3 or 4 when dry. The C horizon has value of 4 to 6 when dry.

Cavour Series

The Cavour series consists of deep, moderately well drained, very slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Cavour loam in an area of Cavour-Cresbard loams, 0 to 3 percent slopes, 125 feet north and 200 feet east of the southwest corner of sec. 13, T. 159 N., R. 58 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; slightly acid; abrupt smooth boundary.

E—7 to 9 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure parting to weak thin platy; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; neutral; abrupt smooth boundary.

Bt—9 to 18 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) clay, dark gray (10YR 4/1) dry; strong medium columnar structure parting to strong medium subangular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; common distinct clay films on faces of peds; thin light gray (10YR 6/1) silt coatings on the top of columns; moderately alkaline; clear smooth boundary.

Bzy—18 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak medium

subangular blocky; hard, firm, sticky and plastic; few very fine roots; common fine and medium masses of salts and gypsum; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bk—25 to 42 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent reddish brown (5YR 4/3) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; about 5 percent gravel; many medium and large soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—42 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent reddish brown (5YR 4/4) mottles; massive; hard, firm, sticky and plastic; about 5 percent gravel; strongly effervescent; moderately alkaline.

The depth to lime ranges from 18 to 32 inches. The depth to gypsum and salts ranges from 16 to 45 inches.

The Ap horizon has value of 2 or 3 (4 or 5 when dry). The E horizon has value of 3 or 4 (5 or 6 when dry). The Ap and E horizons are sometimes mixed as a result of tillage. The Bt horizon has hue of 10YR or 2.5Y and value of 2 to 4 (4 or 5 when dry). It is clay, silty clay, silty clay loam, or clay loam. Some pedons do not have salt and gypsum in the B horizon. The Bk horizon has value of 4 to 6 (6 to 8 when dry). It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (6 or 7 when dry), and chroma of 2 to 4. It is clay loam or loam.

Coe Series

The Coe series consists of deep, excessively drained soils on outwash plains and eskers. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 3 to 9 percent.

Typical pedon of Coe gravelly loam in an area of Vang-Coe complex, 3 to 6 percent slopes, 2,400 feet west and 350 feet south of the northeast corner of sec. 11, T. 161 N., R. 61 W.

Ap—0 to 7 inches; black (10YR 2/1) gravelly loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 20 percent shale gravel; neutral; abrupt wavy boundary.

2C—7 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots to a depth of 27 inches; about 55 percent shale gravel; slightly effervescent; mildly alkaline.

The depth to sand and gravel ranges from 6 to 14 inches. The A horizon has value of 3 or 4 when dry. The 2C horizon has hue of 2.5Y or 5Y and value of 3 or 4 (5 or 6 when dry). It is very gravelly coarse sand, extremely gravelly loamy coarse sand, or very gravelly sand. It is 35 to 70 percent shale gravel.

Colvin Series

The Colvin series consists of deep, very poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Colvin silty clay loam, 2,500 feet south and 450 feet west of the northeast corner of sec. 22, T. 163 N., R. 63 W.

Oe—1 inch to 0; partially decomposed litter of stems, roots, and mosses.

A—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; many fine and few medium roots; few snail shells; slightly effervescent; mildly alkaline; clear wavy boundary.

Bk1—8 to 13 inches; light gray (10YR 7/1) silty clay loam, white (10YR 8/1) dry; common medium prominent light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; common fine and very fine roots; disseminated lime throughout; violently effervescent; mildly alkaline; clear irregular boundary.

Bk2—13 to 23 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; few fine prominent dark yellowish brown (10YR 4/6) mottles and common fine distinct olive brown (2.5Y 4/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; lime disseminated throughout and in common medium soft masses; violently effervescent; mildly alkaline; gradual wavy boundary.

C1—23 to 37 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles and few fine prominent dark reddish brown (5YR 3/3) mottles;

massive; hard, friable, sticky and plastic; few very fine roots; violently effervescent; mildly alkaline; gradual wavy boundary.

C2—37 to 51 inches; light olive brown (2.5Y 5/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent gray (10YR 5/1) mottles and few fine prominent dark reddish brown (5YR 3/3) mottles; massive; hard, friable, sticky and plastic; thin strata of very fine sand; strongly effervescent; mildly alkaline; gradual wavy boundary.

2C3—51 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 7/4) dry; common medium prominent gray (10YR 5/1) mottles and few fine prominent dark reddish brown (5YR 3/3) and dark yellowish brown (10YR 4/6) mottles; massive; hard, friable, sticky and plastic; about 10 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 13 inches. The A horizon has value of 3 or 4 when dry. The Bk horizon has hue of 10YR to 5Y.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

These soils have slightly less clay and sodium in the subsoil than is definitive for the Cresbard series. This difference, however, does not alter the usefulness or behavior of the soil.

Typical pedon of Cresbard loam in an area of Cresbard-Svea loams, 1 to 3 percent slopes, 1,370 feet east and 325 feet south of the northwest corner of sec. 2, T. 161 N., R. 60 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; slightly acid; abrupt smooth boundary.

B/E—8 to 9 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) (B) and light gray (10YR 6/1) (E) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; slightly acid; clear wavy boundary.

Bt1—9 to 14 inches; black (10YR 2/1) clay loam, faces of peds are dark gray (10YR 4/1) dry and interior of peds is very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) dry; moderate medium prismatic structure parting to strong fine and very fine angular blocky; very hard, firm, sticky and plastic; few very fine roots; many distinct clay films on faces of peds; neutral; clear wavy boundary.

Bt2—14 to 18 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate fine and very fine subangular blocky; hard, friable, sticky and plastic; few very fine roots; few faint clay films on faces of peds; neutral; clear wavy boundary.

Bk—18 to 29 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; weak fine prismatic structure parting to weak very fine subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; lime disseminated throughout and in common fine soft masses; violently effervescent; moderately alkaline; gradual irregular boundary.

Bky—29 to 37 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; weak very fine subangular blocky structure; soft, friable, slightly sticky and plastic; few fine masses of gypsum; disseminated lime throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

C—37 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark reddish brown (5YR 3/4) mottles; massive; soft, friable, slightly sticky and slightly plastic; about 5 percent gravel; slightly effervescent; mildly alkaline.

The depth to carbonates ranges from 15 to 22 inches. The Ap horizon has value of 2 or 3 (3 or 4 when dry). The B/E horizon has value of 2 or 3. It is clay loam or silty clay loam. Some pedons have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 when dry), and chroma of 1 to 3. It is clay loam or clay. The Bk horizon has value of 4 to 6 (6 to 8 when dry) and chroma of 2 to 4. It is clay loam, silt loam, or loam. The C horizon has value of 4 to 6 (5 to 7 when dry) and chroma of 2 to 4. It is loam or clay loam.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on outwash plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 3 percent.

Typical pedon of Divide loam, 1 to 3 percent slopes, 1,800 feet north and 300 feet west of the southeast corner of sec. 15, T. 159 N., R. 61 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many fine and very fine roots; about 2 percent gravel; mildly alkaline; abrupt smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate medium granular; soft, friable, slightly sticky and slightly plastic; common fine and very fine roots; about 5 percent gravel; slightly effervescent; mildly alkaline; clear smooth boundary.

Bk—12 to 24 inches; grayish brown (2.5Y 5/2) gravelly loam, light gray (2.5Y 7/2) dry; weak medium and fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; about 25 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; clear smooth boundary.

2C—24 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 45 percent gravel; strongly effervescent; mildly alkaline.

The depth to sand and gravel ranges from 21 to 30 inches. The thickness of the mollic epipedon ranges from 7 to 13 inches.

The A horizon has value of 2 or 3 (3 or 4 when dry). Some pedons have an ABk horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 2 or 3. It is loam or gravelly loam. The 2C horizon has hue of 10YR to 5Y, value of 4 or 5 (6 or 7 when dry), and chroma of 2 to 4. It is very gravelly coarse sand, loamy sand, or sand. It has 10 to 60 percent gravel. In some pedons the sand and gravel are dominantly shale.

Easby Series

The Easby series consists of deep, poorly drained, moderately slowly permeable, strongly saline, highly calcareous soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Easby clay loam, 2,125 feet west and 525 feet south of the northeast corner of sec. 4, T. 160 N., R. 59 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; very hard, friable, sticky and plastic; few fine roots; few fine masses of salt; slightly effervescent; moderately alkaline; abrupt smooth boundary.

ABkyz—7 to 11 inches; dark gray (10YR 4/1) clay loam, gray (10YR 6/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and slightly plastic; few very fine roots; few fine masses of salt and gypsum; disseminated lime throughout; strongly effervescent; moderately alkaline; clear irregular boundary.

Bky—11 to 22 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent dark yellowish brown (10YR 4/6) mottles and common medium prominent brownish yellow (10YR 6/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and slightly plastic; about 2 percent gravel; common fine masses of gypsum; lime disseminated throughout and in few fine soft masses; violently effervescent; moderately alkaline; clear irregular boundary.

C1—22 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct light olive brown (2.5Y 5/4) mottles and few medium prominent dark yellowish brown (10YR 4/6) and gray (10YR 6/1) mottles; massive; slightly hard, friable, sticky and plastic; about 5 percent gravel; few fine masses of gypsum; few fine soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—30 to 43 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; few medium prominent dark brown (10YR 3/3) mottles, common medium prominent gray (10YR 6/1) mottles, few fine prominent dark red (2.5YR 3/6) mottles, and many medium prominent dark brown (7.5YR 4/4) mottles; massive; slightly hard, friable, sticky and plastic; about 10 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

C3—43 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent dark red (2.5YR 3/6), strong brown (7.5YR 4/6), and gray (10YR 6/1) mottles; massive; slightly hard, friable, sticky and plastic; about 10 percent gravel; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 13 inches. The A horizon has hue of 10YR to 5Y and

value of 3 or 4 when dry. The Bky horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The C horizon has hue of 2.5Y or 5Y and value of 3 to 5 (5 to 7 when dry). It is loam or clay loam. Some pedons have a 2C horizon below a depth of 40 inches.

Edgeley Series

The Edgeley series consists of moderately deep, well drained, moderately permeable soils on dissected till plains. These soils formed in glacial till and material weathered from shale. Slope ranges from 6 to 15 percent.

These soils have a slightly thicker mollic epipedon than is definitive for the Edgeley series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Edgeley loam in an area of Kloten-Walsh-Edgeley loams, 6 to 35 percent slopes, 130 feet west and 10 feet north of the southeast corner of sec. 21, T. 163 N., R. 59 W.

A—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slightly acid; clear smooth boundary.

Bw1—9 to 20 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slightly acid; clear wavy boundary.

Bw2—20 to 27 inches; dark grayish brown (2.5Y 4/2) channery loam, grayish brown (2.5Y 5/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; about 30 percent shale channers; slightly acid; clear wavy boundary.

2Cr—27 to 60 inches; dark gray (5Y 4/1) soft shale, gray (5Y 6/1) dry; common fine roots in fissures extend to a depth of 35 inches; yellowish red (5YR 4/6) stains on surface of individual shale fragments.

The depth to shale ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches.

The A horizon has value of 3 or 4 when dry. The Bw horizon has value of 2 to 4 (4 or 5 when dry). The Cr horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 or 6 when dry), and chroma of 1 or 2.

Fairdale Series

The Fairdale series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

These soils do not have the carbonates that are definitive for the Fairdale series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Fairdale loam, channeled, 200 feet east and 850 feet south of the northwest corner of sec. 36, T. 163 N., R. 59 W.

A—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; mildly alkaline; clear wavy boundary.

C1—8 to 29 inches; very dark grayish brown (2.5Y 3/2), stratified fine sandy loam and loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and common very fine roots; mildly alkaline; gradual wavy boundary.

C2—29 to 54 inches; very dark grayish brown (2.5Y 3/2), stratified fine sandy loam and loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; about 2 percent shale gravel; mildly alkaline; gradual wavy boundary.

C3—54 to 60 inches; very dark grayish brown (2.5Y 3/2), stratified loam and fine sandy loam, light brownish gray (2.5Y 6/2) dry; common fine prominent dark brown (7.5YR 3/4) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; about 4 percent shale gravel; mildly alkaline.

The A horizon has value of 2 or 3 (4 or 5 when dry). The C horizon has value of 3 or 4 (4 to 6 when dry). Some pedons have an Ab horizon.

Fordville Series

The Fordville series consists of deep, well drained soils on eskers and till plains. These soils formed in glaciofluvial deposits. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 3 to 9 percent.

Typical pedon of Fordville loam in an area of Fordville-Sioux complex, 3 to 9 percent slopes, 500 feet

west and 2,100 feet south of the northeast corner of sec. 35, T. 161 N., R. 62 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; neutral; abrupt smooth boundary.

Bw—7 to 17 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

Bk—17 to 27 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violently effervescent; mildly alkaline; clear smooth boundary.

2C1—27 to 49 inches; light olive brown (2.5Y 5/4) gravelly loamy sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 15 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.

2C2—49 to 60 inches; olive brown (2.5Y 4/4) gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 20 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 3 or 4 when dry. The Bw horizon has value of 3 or 4 (4 or 5 when dry) and chroma of 2 or 3. The 2C horizon has value of 5 or 6 when dry and chroma of 2 to 4. It is gravelly loamy sand, gravelly sand, or loamy sand.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately rapidly permeable, highly calcareous soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Glyndon silt loam, 1,200 feet south and 235 feet west of the northeast corner of sec. 36, T. 164 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A—8 to 15 inches; black (10YR 2/1) very fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; strongly effervescent; mildly alkaline; clear smooth boundary.

Bk—15 to 28 inches; grayish brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) dry; few medium distinct light brownish gray (2.5Y 6/2) mottles and few fine distinct dark yellowish brown (10YR 3/4) mottles; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C—28 to 60 inches; light olive brown (2.5Y 5/4) loamy very fine sand, light yellowish brown (2.5Y 6/4) dry; few fine faint light olive brown (2.5Y 5/6) mottles; massive; slightly hard, very friable, slightly sticky and nonplastic; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 9 to 15 inches. The A horizon has value of 3 or 4 when dry. The Bk horizon has hue of 10YR or 2.5Y and value of 4 or 5 (5 to 7 when dry). It is very fine sandy loam or loam. The C horizon has value of 4 or 5. It is loamy very fine sand, very fine sandy loam, or very fine sand.

Hamar Series

The Hamar series consists of deep, poorly drained, rapidly permeable soils on delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Hamar loamy fine sand, 800 feet west and 150 feet south of the northeast corner of sec. 15, T. 163 N., R. 57 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; neutral; abrupt smooth boundary.

A—6 to 11 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; few fine distinct brown (10YR 4/3) mottles; weak fine subangular blocky structure; soft, very friable,

nonsticky and nonplastic; few fine roots; neutral; clear smooth boundary.

AC—11 to 19 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; common medium distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; mildly alkaline; gradual wavy boundary.

C1—19 to 44 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, grayish brown (2.5Y 5/2) dry; common medium prominent light olive brown (2.5Y 5/6) mottles and few fine prominent black (N 2/0) and dark reddish brown (5YR 3/3) mottles; single grain; loose, nonsticky and nonplastic; mildly alkaline; gradual wavy boundary.

C2—44 to 60 inches; olive brown (2.5Y 4/4) fine sand, light yellowish brown (2.5Y 6/4) dry; common medium prominent dark reddish brown (5YR 3/4) mottles and common fine prominent dark brown (7.5YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; mildly alkaline.

The A horizon has value of 2 or 3 (4 or 5 when dry) and chroma of 1 or 2. The C horizon has hue of 2.5Y or 10YR. It is loamy fine sand, fine sand, or sand.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam in an area of Hamerly-Tonka loams, 0 to 3 percent slopes, 550 feet east and 800 feet north of the southwest corner of sec. 33, T. 163 N., R. 59 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; common very fine roots; few pebbles; slightly effervescent; mildly alkaline; abrupt wavy boundary.

Bk1—8 to 17 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; few pebbles; disseminated lime throughout; violently effervescent; mildly alkaline; clear smooth boundary.

Bk2—17 to 35 inches; olive brown (2.5Y 4/4) clay loam, pale yellow (2.5Y 7/4) dry; common fine and medium prominent dark red (2.5YR 3/6) mottles; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; about 10 percent shale channers; disseminated lime throughout; violently effervescent; moderately alkaline; clear smooth boundary.

C—35 to 60 inches; light olive brown (2.5Y 5/4) clay loam, pale yellow (2.5Y 8/4) dry; common medium prominent yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; about 5 percent gravel; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. Some pedons are saline.

The Ap horizon has value of 2 to 3 (3 to 5 when dry). The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 8 when dry), and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 when dry), and chroma of 2 to 4. It is loam or clay loam.

Hattie Series

The Hattie series consists of deep, moderately well drained, slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 1 to 3 percent.

Typical pedon of Hattie clay, 1 to 3 percent slopes, 900 feet north and 850 feet east of the southwest corner of sec. 17, T. 163 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bw—7 to 16 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; tongues of black (10YR 2/1) material from the A horizon ¼ to ¾ inch wide extend through this horizon; slightly effervescent; mildly alkaline; clear smooth boundary.

Bk—16 to 27 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; very hard, firm, very sticky and very plastic; tongues of black (10YR 2/1) material from the A horizon ¼ to ¾ inch wide extend through this horizon; common medium irregular soft masses of lime; strongly effervescent;

moderately alkaline; gradual wavy boundary.

C1—27 to 37 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; massive; very hard, firm, very sticky and very plastic; about 5 percent gravel; tongues of black (10YR 2/1) material from the A horizon ¼ to ¾ inch wide extend through this horizon; strongly effervescent; mildly alkaline; gradual wavy boundary.

C2—37 to 60 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; massive; very hard, firm, very sticky and very plastic; about 10 percent gravel; tongues of black (10YR 2/1) material from the A horizon ¼ to ¾ inch wide extend to a depth of 45 inches; few fine masses of gypsum; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 20 inches. The Bw horizon has hue of 2.5Y or 5Y and value of 3 or 4 (4 or 5 when dry). It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 2 to 4.

Hegne Series

The Hegne series consists of deep, poorly drained, very slowly permeable, highly calcareous soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Hegne silty clay, 950 feet north and 100 feet east of the southwest corner of sec. 36, T. 164 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine and fine roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; few very fine roots; slightly effervescent; mildly alkaline; gradual wavy boundary.

Bkg1—11 to 19 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; moderate fine subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; tongues of black (10YR 2/1) material from the A horizon extend through this horizon; disseminated lime throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

Bkg2—19 to 36 inches; gray (5Y 5/1) silty clay, light gray (5Y 6/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; tongues of black (10YR 2/1) material from the A horizon extend through this horizon; disseminated lime throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

Cg—36 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; few fine faint dark grayish brown (2.5Y 4/2) mottles and few fine prominent yellowish red (5YR 5/6) mottles; massive; very hard, firm, very sticky and very plastic; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. Some pedons are saline.

The Ap horizon has value of 2 or 3 (3 or 4 when dry). The Bkg horizon has chroma of 1 or 2. The Cg horizon has hue of 5Y or 2.5Y, value of 4 or 5 (5 or 6 when dry), and chroma of 1 or 2. It is silty clay or clay. In some pedons gypsum is in the C horizon.

Inkster Series

The Inkster series consists of deep, well drained, moderately rapidly permeable soils on outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Inkster loam, 0 to 3 percent slopes, 2,120 feet south and 710 feet west of the northeast corner of sec. 12, T. 162 N., R. 57 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; medium acid; abrupt smooth boundary.

A—6 to 10 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, sticky and plastic; common very fine roots; medium acid; abrupt wavy boundary.

Bw—10 to 19 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots; medium acid; gradual wavy boundary.

C1—19 to 37 inches; very dark grayish brown (2.5Y 3/2) sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; soft, friable, slightly sticky and slightly plastic; few very fine roots; medium acid; gradual smooth boundary.

C2—37 to 60 inches; very dark grayish brown (2.5Y 3/2) loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 3 percent shale gravel; 1-inch-thick strata of dark reddish brown (5YR 3/4) sand; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 23 inches. The sand-sized fraction is dominantly weathered shale particles. These particles crush easily when they are wet.

The A horizon has value of 3 or 4 when dry. The Bw horizon has hue of 10YR or 2.5Y. It is fine sandy loam or sandy loam. Some pedons have a BC horizon. The C horizon has hue of 2.5Y or 10YR and chroma of 2 to 4.

Kelvin Series

The Kelvin series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Kelvin loam in an area of Suomi-Kelvin complex, 0 to 3 percent slopes, 460 feet north and 300 feet west of the southeast corner of sec. 27, T. 164 N., R. 58 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, gray (10YR 6/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; neutral; abrupt smooth boundary.

Bt1—7 to 14 inches; dark grayish brown (10YR 4/2) clay loam, light brownish gray (10YR 6/2) dry; moderate medium prismatic structure parting to moderate fine and medium angular blocky; hard, firm, sticky and plastic; few very fine roots; common distinct clay films on faces of peds; dark gray (10YR 4/1) stains on faces of peds; neutral; clear wavy boundary.

Bt2—14 to 20 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium prismatic structure parting to moderate fine and very fine angular blocky; hard, firm, sticky and plastic; few very fine roots; common distinct clay films on faces of peds; dark gray (10YR 4/1) stains on faces of peds; mildly alkaline; clear irregular boundary.

Bw—20 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; about 2 percent gravel; mildly alkaline; clear irregular boundary.

Bk—28 to 48 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent red (2.5YR 5/6) and reddish yellow (7.5YR 6/6) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; about 4 percent gravel; lime disseminated throughout and in common large threads and filaments; violently effervescent; mildly alkaline; clear irregular boundary.

C—48 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark red (2.5YR 3/6) mottles and common medium prominent reddish yellow (7.5YR 6/8) mottles; massive; hard, firm, slightly sticky and slightly plastic; about 10 percent gravel; strongly effervescent; mildly alkaline.

The depth to carbonates ranges from 25 to 37 inches. The Ap horizon has value of 5 or 6 when dry. Some pedons have an E or B/E horizon 3 to 6 inches thick. The Bt horizon has value of 4 or 5 (5 or 6 when dry) and chroma of 2 to 4. It is clay loam or clay. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 when dry), and chroma of 2 to 4. It ranges in thickness from 0 to 25 inches. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam.

Kloten Series

The Kloten series consists of shallow, well drained, moderately permeable soils on dissected till plains. These soils formed in material weathered from shale. Slope ranges from 6 to 120 percent.

Typical pedon of Kloten loam in an area of Kloten-Walsh-Edgeley loams, 6 to 35 percent slopes, 2,100 feet east and 60 feet north of the southwest corner of sec. 27, T. 163 N., R. 59 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few pebbles; slightly acid; clear smooth boundary.

C—7 to 14 inches; very dark grayish brown (2.5Y 3/2) channery loam, grayish brown (2.5Y 5/2) dry; weak coarse prismatic structure parting to weak very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 15 percent shale channers; slightly acid; clear smooth boundary.

2R—14 to 60 inches; olive gray (5Y 4/2) shale, light olive gray (5Y 6/2) dry; common prominent strong brown (7.5YR 5/6) stains on surfaces of shale fragments.

The depth to shale ranges from 9 to 20 inches. The A horizon has value of 2 or 3. The C horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is loam or channery loam.

La Prairie Series

The La Prairie series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of La Prairie loam, 2,400 feet west and 300 feet north of the southeast corner of sec. 27, T. 164 N., R. 64 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; neutral; abrupt smooth boundary.

A—7 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; mildly alkaline; clear smooth boundary.

Bw1—18 to 25 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine roots; mildly alkaline; clear smooth boundary.

Bw2—25 to 31 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine soft masses of lime; strongly effervescent; mildly alkaline; gradual wavy boundary.

C1—31 to 46 inches; dark grayish brown (2.5Y 4/2) loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; thin strata of fine sandy loam; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—46 to 60 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon and the depth to carbonates range from 16 to 32 inches. Some pedons have an Ab horizon.

The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has value of 4 or 5 when dry. The C horizon has value of 4 or 5 (5 or 6 when dry). It is loam, fine sandy loam, or clay loam. Some pedons have strata of coarser material below a depth of 40 inches.

Lamoure Series

The Lamoure series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Lamoure silt loam, 275 feet south and 200 feet east of the northwest corner of sec. 3, T. 163 N., R. 64 W.

A1—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and common medium roots; few fine masses of salts; slightly effervescent; mildly alkaline; gradual smooth boundary.

A2—7 to 16 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; few fine prominent dark grayish brown (2.5Y 4/2) and dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; slightly effervescent; moderately alkaline; gradual smooth boundary.

A3—16 to 22 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; common fine prominent dark yellowish brown (10YR 4/4) mottles and few fine prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure parting to strong coarse granular; hard, friable, slightly sticky and slightly plastic; common fine roots; strongly effervescent; mildly alkaline; gradual smooth boundary.

A4—22 to 38 inches; very dark gray (10YR 3/1) silt

loam, gray (10YR 5/1) dry; few fine prominent dark brown (7.5YR 4/4) mottles and few fine distinct black (N 2/0) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few thin strata of fine sandy loam; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cg—38 to 60 inches; dark olive gray (5Y 3/2) loam, light olive gray (5Y 6/2) dry; common fine distinct dark grayish brown (2.5Y 4/2) mottles, few fine prominent gray (10YR 5/1) mottles, and common fine prominent dark brown (7.5YR 4/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; thin strata of fine sand; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 38 inches. The depth to carbonates ranges from 0 to 10 inches. Some pedons have an Ab horizon.

The A horizon has value of 3 to 5 when dry. The Cg horizon has hue of 2.5Y or 5Y and value of 3 or 4 (4 to 6 when dry). It is loam, clay loam, or silty clay loam.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 35 percent.

Typical pedon of Maddock loamy fine sand, 1 to 6 percent slopes, 1,700 feet south and 2,200 feet west of the northeast corner of sec. 23, T. 163 N., R. 57 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; slightly acid; abrupt smooth boundary.

Bw—8 to 13 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; slightly acid; gradual smooth boundary.

C1—13 to 20 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; slightly acid; clear irregular boundary.

C2—20 to 36 inches; dark brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; slightly acid; clear wavy boundary.

C3—36 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; mildly alkaline.

The thickness of the mollic epipedon ranges from 12 to 16 inches. The A horizon has value of 2 or 3 (3 or 4 when dry). The Bw horizon has value of 3 or 4 (4 or 5 when dry) and chroma of 2 to 4. It is loamy sand or loamy fine sand. Some pedons do not have a Bw horizon, but they have an AC horizon. The C horizon has value of 3 to 6 (5 to 7 when dry) and chroma of 2 to 4. It commonly is loamy fine sand, loamy sand, fine sand, or sand. In some pedons the C horizon is loam or clay loam below a depth of 40 inches.

Manfred Series

The Manfred series consists of deep, poorly drained, slowly permeable, alkali soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Manfred silty clay loam in an area of Manfred-Vallers, saline, silty clay loams, 1,125 feet west and 350 feet south of the northeast corner of sec. 12, T. 159 N., R. 58 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; moderately alkaline; abrupt smooth boundary.

Btg—7 to 14 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; few fine prominent dark red (2.5YR 3/6) mottles and common medium distinct olive (5Y 4/3) mottles; strong medium subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; many distinct clay films on the faces of peds; moderately alkaline; clear wavy boundary.

Bkg—14 to 30 inches; light olive gray (5Y 6/2) silty clay loam, light gray (5Y 7/2) dry; common medium and large prominent strong brown (7.5YR 5/6) mottles and few fine prominent dark red (2.5YR 3/6) mottles; weak medium subangular blocky structure; hard, friable, sticky and plastic; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg1—30 to 44 inches; olive gray (5Y 4/2) clay loam, light gray (5Y 7/2) dry; few fine prominent dark red (2.5YR 3/6) mottles and common fine prominent yellowish brown (10YR 5/8) mottles; massive; hard,

friable, sticky and plastic; about 10 percent shale gravel; few fine manganese concretions; slightly effervescent; moderately alkaline; gradual wavy boundary.

Cg2—44 to 60 inches; light olive brown (2.5Y 5/4) gravelly clay loam, pale yellow (2.5Y 7/4) dry; common fine distinct yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 30 percent shale gravel; moderately alkaline.

The A horizon has value of 2 or 3 (4 or 5 when dry). The Btg horizon has hue of 5Y or 2.5Y and chroma of 1 or 2. The Bkg horizon has hue of 5Y or 2.5Y. It is silty clay loam or clay loam. The Cg horizon is loam, silty clay loam, gravelly clay loam, or clay loam. Some pedons have thin layers of sand or clay in the Cg horizon.

Mekinock Series

The Mekinock series consists of moderately deep, moderately well drained, very slowly permeable, alkali soils on till plains. These soils formed in glacial till and material weathered from soft shale. Slope ranges from 0 to 6 percent.

Typical pedon of Mekinock loam, 0 to 6 percent slopes, 200 feet south and 875 feet east of the northwest corner of sec. 6, T. 163 N., R. 57 W.

E—0 to 2 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; medium acid; abrupt smooth boundary.

Bt—2 to 11 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; strong coarse columnar structure parting to strong medium angular blocky; extremely hard, very firm, very sticky and very plastic; common fine roots confined to faces of peds; many distinct clay films on faces of peds; light gray (10YR 7/2) silt coatings on the top of columns; moderately alkaline; clear smooth boundary.

Btyz—11 to 16 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; strong coarse prismatic structure parting to strong medium and fine angular blocky; very hard, very firm, very sticky and very plastic; few very fine roots confined to faces of peds; common distinct clay films on faces of peds; common fine masses of salt and gypsum; slightly effervescent; moderately alkaline; clear smooth boundary.

2C—16 to 25 inches; dark olive gray (5Y 3/2) clay, light olive gray (5Y 6/2) dry; massive with few laminations characteristic of the shale; very hard, firm, very sticky and very plastic; few very fine roots; common fine masses of salt and gypsum; mildly alkaline; gradual wavy boundary.

2Cr—25 to 60 inches; dark gray (5Y 4/1) shale, gray (5Y 6/1) dry; common prominent dark reddish brown (5YR 3/4) stains on shale fragments.

The depth to gypsum and salts ranges from 9 to 15 inches. The depth to shale ranges from 22 to 35 inches.

The E horizon has value of 3 or 4 and chroma of 1 or 2. Some pedons have an A horizon 1 inch to 2 inches thick. The Bt horizon has hue of 10YR to 5Y and value of 3 or 4 (4 or 5 when dry). It is clay, silty clay, or clay loam. The 2C horizon has value of 3 or 4 (5 or 6 when dry). The 2Cr horizon has value of 4 or 5 (5 or 6 when dry) and chroma of 1 or 2.

Miranda Series

The Miranda series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Miranda loam in an area of Miranda-Cavour loams, 970 feet west and 1,400 feet north of the southeast corner of sec. 31, T. 163 N., R. 59 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

Bt—8 to 15 inches; black (10YR 2/1) and dark brown (10YR 3/3) clay loam, very dark gray (10YR 3/1) and brown (10YR 5/3) dry; strong medium columnar structure parting to strong fine and medium angular blocky; extremely hard, firm, very sticky and very plastic; few very fine roots; many distinct clay films on faces of peds; thin light gray (10YR 6/1) silt coatings on the top of columns; mildly alkaline; gradual smooth boundary.

Bkyz—15 to 19 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (2.5Y 4/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard, friable, sticky and

plastic; few very fine roots; about 5 percent gravel; few fine masses of salt and gypsum; lime disseminated throughout and in few fine soft masses; strongly effervescent; moderately alkaline; clear wavy boundary.

Bkz—19 to 32 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common fine faint light gray (5Y 7/2) mottles and few fine prominent strong brown (7.5YR 5/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; soft, very friable, sticky and plastic; few very fine roots; about 5 percent gravel; few fine masses of salt; lime disseminated throughout and in few fine soft masses; violently effervescent; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; olive brown (2.5Y 4/4) clay loam, pale yellow (2.5Y 7/4) dry; few medium prominent light gray (5Y 7/2) mottles and few fine prominent dark brown (7.5YR 3/2) mottles; massive; slightly hard, friable, sticky and plastic; about 5 percent gravel; slightly effervescent; moderately alkaline.

The depth to lime ranges from 12 to 20 inches. The depth to salt and gypsum ranges from 12 to 16 inches.

The Ap horizon has value of 4 or 5 when dry. The Bt horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 6 when dry). The Bk horizon has hue of 10YR to 5Y. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (6 or 7 when dry), and chroma of 2 to 4. It is loam or clay loam.

Olga Series

The Olga series consists of deep, well drained, slowly permeable soils on dissected till plains. These soils formed in glacial till, colluvium, and material weathered from bedrock. Slope ranges from 9 to 35 percent.

Typical pedon of Olga silty clay loam, 15 to 35 percent slopes, 850 feet west and 1,500 feet north of the southeast corner of sec. 29, T. 164 N., R. 57 W.

Oe—1 inch to 0; partially decomposed litter of leaves, grass, and roots.

A—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) and gray (10YR 5/1) dry; weak medium subangular blocky structure; very hard, firm, sticky and plastic; few coarse and medium roots and common fine roots; medium acid; clear smooth boundary.

E—7 to 12 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; strong fine and medium subangular blocky structure; hard, firm, slightly sticky and plastic; few coarse and medium roots and common fine roots; light gray (10YR 7/1) silt coatings on faces of peds; medium acid; clear smooth boundary.

Bt1—12 to 23 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; moderate medium prismatic structure parting to strong medium subangular blocky; very hard, very firm, very sticky and very plastic; few medium and fine roots; many distinct clay films on faces of peds; very strongly acid; gradual wavy boundary.

Bt2—23 to 30 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic; few medium and fine roots; many faint clay films on the faces of peds; few fine masses of yellow (2.5Y 7/6) sulfur; about 3 percent shale channers; very strongly acid; gradual wavy boundary.

C—30 to 50 inches; dark gray (5Y 4/1) channery silty clay, gray (5Y 6/1) dry; massive; very hard, firm, very sticky and very plastic; few fine and medium masses of yellow (2.5Y 7/6) sulfur; about 25 percent shale channers; very strongly acid; abrupt wavy boundary.

2Cr—50 to 60 inches; very dark gray (5Y 3/1) soft shale, gray (5Y 5/1) dry.

The thickness of the mollic epipedon ranges from 7 to 10 inches. The depth to shale ranges from 45 to 60 inches or more.

The E horizon has value of 3 or 4 and chroma of 1 or 2. It is silty clay loam or silt loam. The Bt horizon has hue of 2.5Y or 5Y, value of 3 or 4 (5 or 6 when dry), and chroma of 1 or 2. It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y, value of 6 or 7 when dry, and chroma of 1 or 2. It is channery silty clay or clay loam. It is 10 to 30 percent shale channers.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Parnell silt loam in an area of Vallers, saline-Parnell complex, 1,400 feet west and 700 feet north of the southeast corner of sec. 14, T. 159 N., R. 64 W.

Oi—1 inch to 0; litter of stems, leaves, and roots.

A1—0 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many coarse, fine, and very fine roots; slightly acid; gradual wavy boundary.

A2—11 to 24 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; clear wavy boundary.

Bt1—24 to 36 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; extremely hard, firm, slightly sticky and slightly plastic; few fine and very fine roots; many faint clay films on faces of peds; common uncoated sand grains on faces of peds; mildly alkaline; gradual wavy boundary.

Bt2—36 to 43 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common fine prominent strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; extremely hard, firm, sticky and plastic; few very fine roots; many faint clay films on faces of peds; common uncoated sand grains on faces of peds; neutral; gradual wavy boundary.

Cg—43 to 60 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; common medium prominent strong brown (7.5YR 5/8) mottles; massive; extremely hard, firm, slightly sticky and slightly plastic; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 30 to 60 inches. The A horizon has hue of 10YR, or it is neutral. It has value of 2 or 3 and chroma of 0 to 1. Some pedons have an E horizon 1 inch to 4 inches thick. The Bt horizon has value of 3 or 4 when dry and chroma of 1 or 2. It is silty clay loam, silty clay, or clay loam. The C horizon has hue of 2.5Y or 5Y and value of 4 or 6 (6 to 8 when dry). It is silty clay loam or clay loam.

Rolette Series

The Rolette series consists of deep, moderately well drained, moderately slowly permeable soils on mantled delta plains. These soils formed in colluvium. Slopes range from 1 to 9 percent.

Typical pedon of Rolette clay loam, 3 to 6 percent slopes, 1,750 feet south and 175 feet west of the northeast corner of sec. 32, T. 164 N., R. 57 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine and very fine roots; neutral; abrupt smooth boundary.

E/B—8 to 12 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, light brownish gray (2.5Y 6/2) (E) and grayish brown (2.5Y 5/2) (B) dry; moderate fine and very fine subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; neutral; clear smooth boundary.

Bt1—12 to 21 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to strong medium and fine angular blocky; hard, firm, very sticky and very plastic; few very fine roots; many distinct clay films on faces of peds; uncoated sand and silt grains on faces of peds; neutral; gradual wavy boundary.

Bt2—21 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, very sticky and very plastic; few very fine roots; many faint clay films on faces of peds; uncoated sand and silt grains on faces of peds; about 3 percent gravel; neutral; clear irregular boundary.

Bk—28 to 49 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few fine prominent reddish brown (5YR 4/4) mottles; weak medium subangular blocky structure; hard, friable, sticky and slightly plastic; few very fine roots; about 3 percent gravel; lime disseminated throughout and in common soft masses; violently effervescent; mildly alkaline; gradual wavy boundary.

C—49 to 60 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine prominent dark brown (7.5YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strongly effervescent; mildly alkaline.

The depth to lime ranges from 22 to 31 inches. The A horizon has value of 3 or 4 when dry. It is clay loam or silty clay loam. The E/B horizon has hue of 10YR or 2.5Y, value of 4 to 6 when dry, and chroma of 1 or 2. It is clay loam or silty clay loam. Some pedons have a B/E horizon. The Bt horizon has hue of 2.5Y or 5Y and value of 3 or 4 (4 to 6 when dry). It is silty clay or clay. The Bk horizon has value of 4 or 5 (6 or 7 when dry). It is clay loam or silty clay loam. The C horizon has value of 4 or 5 (6 or 7 when dry). It commonly is clay loam or

silty clay loam. In some pedons the C horizon has strata of sand or clay below a depth of 40 inches.

Roliss Series

The Roliss series consists of deep, very poorly drained, moderately slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Roliss silt loam, 125 feet north and 100 feet west of the southeast corner of sec. 31, T. 161 N., R. 59 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few snail shells; neutral; abrupt smooth boundary.

A—8 to 19 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; few medium prominent dark brown (7.5YR 3/4) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few snail shells; slightly effervescent; mildly alkaline; clear wavy boundary.

2Bg1—19 to 26 inches; olive gray (5Y 5/2) clay loam, light gray (5Y 7/2) dry; few fine prominent dark reddish brown (5YR 3/4) mottles, common medium prominent dark yellowish brown (10YR 4/6) mottles, and common medium distinct olive brown (2.5Y 4/4) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, friable, sticky and plastic; about 5 percent gravel; few snail shells; slightly effervescent; mildly alkaline; gradual wavy boundary.

2Bg2—26 to 33 inches; olive gray (5Y 4/2) clay loam, light olive gray (5Y 6/2) dry; few fine prominent dark reddish brown (5YR 3/4) mottles, common medium prominent dark yellowish brown (10YR 4/6) mottles, and common large distinct very dark gray (5Y 3/1) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; hard, friable, sticky and plastic; about 5 percent gravel; slightly effervescent; mildly alkaline; gradual wavy boundary.

2Cg1—33 to 40 inches; olive gray (5Y 4/2) loam, light olive gray (5Y 6/2) dry; few fine prominent dark reddish brown (5YR 3/4) mottles, many fine prominent dark yellowish brown (10YR 4/6) mottles, and few medium distinct very dark gray (5Y 3/1) mottles; massive; hard, friable, sticky and plastic; about 10 percent gravel; slightly effervescent; mildly alkaline; gradual wavy boundary.

2Cg2—40 to 60 inches; olive gray (5Y 4/2) loam, olive (5Y 5/3) dry; few fine prominent very dusky red (2.5YR 2/2) mottles, common fine prominent dark brown (7.5YR 4/4) mottles, and few medium distinct olive brown (2.5Y 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few thin strata of fine sandy loam; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 12 to 19 inches. The A horizon has value of 2 or 3. The Bg horizon is clay loam or silty clay loam. Some pedons have a Bk horizon. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 2 to 4. It is loam or clay loam.

Sioux Series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on outwash plains and on eskers on till plains. These soils formed in glaciofluvial deposits. Slope ranges from 3 to 9 percent.

Typical pedon of Sioux gravelly loam in an area of Fordville-Sioux complex, 3 to 9 percent slopes, 2,000 feet south and 600 feet west of the northeast corner of sec. 35, T. 161 N., R. 62 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) gravelly loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; about 15 percent gravel; strongly effervescent; mildly alkaline; abrupt smooth boundary.

AC—7 to 10 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; about 30 percent gravel; lime disseminated throughout and as coatings on the underside of pebbles; violently effervescent; moderately alkaline; clear wavy boundary.

2C1—10 to 28 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) very gravelly sand, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) dry; single grain; loose, nonsticky and nonplastic; about 35 percent gravel; thin strata of fine sandy loam; lime coatings on the underside of pebbles; strongly effervescent; mildly alkaline; clear wavy boundary.

2C2—28 to 60 inches; dark brown (10YR 4/3) and dark

yellowish brown (10YR 4/4) very gravelly sand, yellowish brown (10YR 5/4) and pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 45 percent gravel; lime coatings on the underside of pebbles; strongly effervescent; moderately alkaline.

The depth to sand and gravel ranges from 7 to 13 inches. The A horizon has value of 4 or 5 when dry. The AC horizon has value of 3 or 4 (5 or 6 when dry) and chroma of 2 or 3. The 2C horizon has value of 4 or 5. It is 35 to 50 percent gravel.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on till plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam clay, 1,300 feet north and 175 feet west of the southeast corner of sec. 5, T. 159 N., R. 63 W.

A—0 to 27 inches; black (10YR 2/1) clay, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots in the upper part; few snail shell fragments; strongly effervescent; mildly alkaline; gradual wavy boundary.

Ag1—27 to 44 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; very hard, firm, very sticky and very plastic; common fine snail shell fragments; slightly effervescent; mildly alkaline; gradual wavy boundary.

Ag2—44 to 53 inches; very dark gray (5Y 3/1) clay, gray (5Y 5/1) dry; few fine distinct olive (5Y 4/4) mottles; very hard, very firm, very sticky and very plastic; about 2 percent gravel; few fine snail shell fragments; few fine manganese concretions; few fine masses of gypsum; slightly effervescent; mildly alkaline; gradual wavy boundary.

Cg—53 to 60 inches; dark olive gray (5Y 3/2) clay, gray (5Y 5/1) dry; few medium faint very dark gray (5Y 3/1) mottles and common medium distinct olive (5Y 4/3) mottles; very hard, very firm, sticky and plastic; about 2 percent gravel; few fine snail shell fragments; few fine manganese concretions; mildly alkaline; slightly effervescent.

The thickness of the mollic epipedon ranges from 30 to 60 inches. Some pedons have an O horizon 1 inch to 5 inches thick.

The A horizon has hue of 10YR to 5Y, or it is neutral. It has chroma of 0 or 1. The C horizon has hue of 2.5Y or 5Y, value of 3 or 4 (5 to 7 when dry), and chroma of 1 or 2. It is clay loam, silty clay, or clay. Some pedons have a 2C horizon.

Suomi Series

The Suomi series consists of deep, somewhat poorly drained, slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Suomi silty clay loam in an area of Suomi-Kelvin complex, 0 to 3 percent slopes, 1,900 feet north and 250 feet west of the southeast corner of sec. 33, T. 164 N., R. 58 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, light gray (10YR 6/1) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and slightly plastic; few fine roots; neutral; abrupt smooth boundary.

E—6 to 9 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 6/1) dry; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few uncoated sand grains on the faces of peds; neutral; abrupt wavy boundary.

Bt1—9 to 17 inches; very dark grayish brown (10YR 3/2) clay, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, very sticky and very plastic; few very fine roots; many distinct clay films on faces of peds; about 2 percent gravel; mildly alkaline; gradual smooth boundary.

Bt2—17 to 25 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry; common fine distinct grayish brown (2.5Y 5/2) mottles and few fine prominent yellowish red (5YR 5/8) mottles; moderate fine angular blocky structure; hard, firm, very sticky and very plastic; common faint clay films on faces of peds; about 1 percent gravel; mildly alkaline; gradual wavy boundary.

Bt3—25 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few fine and common medium prominent yellowish red (5YR 5/6) mottles; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common distinct clay films on faces of peds; about 1 percent gravel; few fine soft masses of lime; slightly effervescent; mildly alkaline; gradual wavy boundary.

C—31 to 60 inches; grayish brown (2.5Y 5/2) silty clay

loam, light gray (2.5Y 7/2) dry; common fine distinct light olive brown (2.5Y 5/4) mottles and few fine prominent yellowish red (5YR 5/8) and strong brown (7.5YR 5/6) mottles; massive; hard, firm, sticky and plastic; about 1 percent gravel; strongly effervescent; mildly alkaline.

The depth to lime ranges from 25 to 36 inches. The Ap horizon has value of 6 or 7 when dry. The E horizon has value of 4 or 5 (5 to 7 when dry) and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has value of 3 to 5 (3 to 6 when dry). It is silty clay loam, silty clay, or clay. Some pedons have a Bk horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 1 to 4. It is loam, clay loam, or silty clay loam.

Svea Series

The Svea series consists of deep, well drained and moderately well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Svea loam in an area of Svea-Buse loams, 3 to 6 percent slopes, 1,800 feet east and 725 feet north of the southwest corner of sec. 17, T. 161 N., R. 62 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

A—6 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate coarse prismatic structure parting to moderate medium angular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; neutral; clear wavy boundary.

Bw—14 to 21 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate coarse angular blocky; slightly hard, friable, sticky and plastic; many very fine roots; many very fine soft masses of lime at a depth of 19 to 21 inches; mildly alkaline; clear irregular boundary.

Bk1—21 to 31 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few pebbles; disseminated lime throughout; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bk2—31 to 42 inches; light yellowish brown (2.5Y 6/4) loam, light gray (2.5Y 7/2) dry; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; lime disseminated throughout and in few fine soft masses; strongly effervescent; moderately alkaline; clear wavy boundary.

C1—42 to 53 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, sticky and plastic; many soft masses of lime; slightly effervescent; moderately alkaline; clear wavy boundary.

C2—53 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) when dry; few large prominent light yellowish brown (2.5Y 6/4) mottles; massive; slightly hard, friable, sticky and plastic; about 10 percent gravel; few coarse soft masses of lime; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 to 3 (3 to 5 when dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 or 5 when dry), and chroma of 1 to 3. It is loam, silt loam, or clay loam. The Bk horizon has value of 5 to 6 (6 to 8 when dry). It is loam, silt loam, or clay loam. The C horizon has value of 4 to 6 (5 to 7 when dry). It is loam or clay loam.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on till plains. These soils formed in alluvium and glacial till. Slope is 0 to 1 percent.

Typical pedon of Tonka loam in an area of Hamerly-Tonka loams, 0 to 3 percent slopes, 800 feet east and 1,000 feet north of the southwest corner of sec. 23, T. 163 N., R. 59 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; neutral; abrupt smooth boundary.

E—7 to 13 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate thin and medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; medium acid; abrupt wavy boundary.

Bt1—13 to 25 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish red (5YR 5/8) mottles;

weak fine prismatic structure parting to moderate fine and very fine subangular blocky; soft, friable, sticky and plastic; few very fine roots; common faint clay films on faces of peds; common uncoated sand grains on faces of peds; neutral; clear smooth boundary.

Bt2—25 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine prominent yellowish red (5YR 5/8) mottles; weak fine and medium prismatic structure parting to moderate very fine subangular blocky; soft, friable, sticky and plastic; few very fine roots; many faint clay films on faces of peds; few uncoated sand grains on faces of peds; neutral; clear wavy boundary.

Bk—31 to 51 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles and few fine prominent red (2.5YR 4/8) mottles; moderate thin and very thin platy structure; hard, friable, sticky and plastic; about 5 percent gravel; lime disseminated throughout and in few fine masses; violently effervescent; mildly alkaline; clear wavy boundary.

C—51 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; many medium and large prominent strong brown (7.5YR 5/6) mottles; massive; hard, firm, sticky and plastic; about 5 percent gravel; strongly effervescent; mildly alkaline.

The Ap horizon has value of 3 to 5 when dry. The E horizon has value of 6 or 7 when dry and chroma of 1 or 2. It is loam, silt loam, or silty clay loam. The Bt horizon has value of 4 to 6 when dry and chroma of 1 or 2. It is silty clay loam or clay loam. The C horizon has hue of 10YR to 5Y, value of 4 or 5 (5 to 7 when dry), and chroma of 2 to 4. It is clay loam or loam.

Vallers Series

The Vallers series consists of deep, poorly drained, moderately slowly permeable, saline, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Vallers loam in an area of Vallers, saline-Parnell complex, 850 feet east and 1,000 feet north of the southwest corner of sec. 14, T. 159 N., R. 64 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine masses of salt; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Ay—7 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine masses of gypsum; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Bk—11 to 17 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; lime disseminated throughout and in few fine soft masses; violently effervescent; moderately alkaline; clear irregular boundary.

Bkyg—17 to 23 inches; light olive gray (5Y 6/2) silty clay loam, light gray (5Y 7/1) dry; few medium prominent brownish yellow (10YR 6/8) mottles; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, firm, sticky and plastic; few fine masses of gypsum; lime disseminated throughout and in few fine soft masses; violently effervescent; moderately alkaline; clear wavy boundary.

C1—23 to 30 inches; light brownish gray (2.5Y 6/2) clay loam, light gray (2.5Y 7/2) dry; few fine distinct olive yellow (2.5Y 6/8) mottles and few fine prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, firm, sticky and plastic; about 2 percent gravel; violently effervescent; mildly alkaline; clear wavy boundary.

C2—30 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct olive yellow (2.5Y 6/6) mottles and few fine prominent red (2.5YR 4/8) mottles; massive; hard, firm, sticky and plastic; about 2 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 17 inches. The A horizon has hue of 10YR, or it is neutral. It has value of 2 or 3 (3 to 5 when dry) and chroma of 0 to 1. It is loam or silty clay loam. The Bk horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 8 when dry), and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 when dry), and chroma of 1 to 3. It is clay loam or loam.

Vang Series

The Vang series consists of deep, well drained soils on eskers, outwash plains, and delta plains. These soils formed in glaciofluvial deposits. Permeability is

moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 0 to 9 percent.

Typical pedon of Vang loam, 0 to 3 percent slopes, 1,000 feet west and 390 feet south of the northeast corner of sec. 15, T. 162 N., R. 57 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; slightly hard, very friable, sticky and plastic; common very fine roots; slightly acid; abrupt smooth boundary.

A—7 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; slightly acid; clear wavy boundary.

Bw1—11 to 19 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark grayish brown (2.5Y 4/2) dry; weak medium prismatic structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; few very fine roots; about 5 percent shale gravel; slightly acid; gradual wavy boundary.

Bw2—19 to 27 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; slightly hard, very friable, sticky and plastic; few very fine roots; about 10 percent shale gravel; slightly acid; clear wavy boundary.

2C—27 to 60 inches; very dark grayish brown (2.5Y 3/2) very gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; about 35 percent shale gravel; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 33 inches. The depth to sand and gravel ranges from 20 to 40 inches.

The A horizon has value of 2 or 3. The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 when dry), and chroma of 1 to 3. It has 1 to 15 percent shale gravel. Some pedons have a Bk horizon. The 2C horizon has hue of 2.5Y to 5Y, value of 2 to 4 (5 to 7 when dry), and chroma of 1 to 4. It is very gravelly sand, gravelly coarse sand, or extremely gravelly loamy sand. It has 30 to 80 percent shale gravel.

Walsh Series

The Walsh series consists of deep, well drained, moderately permeable soils on outwash plains and on till plains, some of which are dissected (fig. 9). These soils formed in glaciofluvial deposits, glacial till, and colluvium. Slope ranges from 0 to 15 percent.

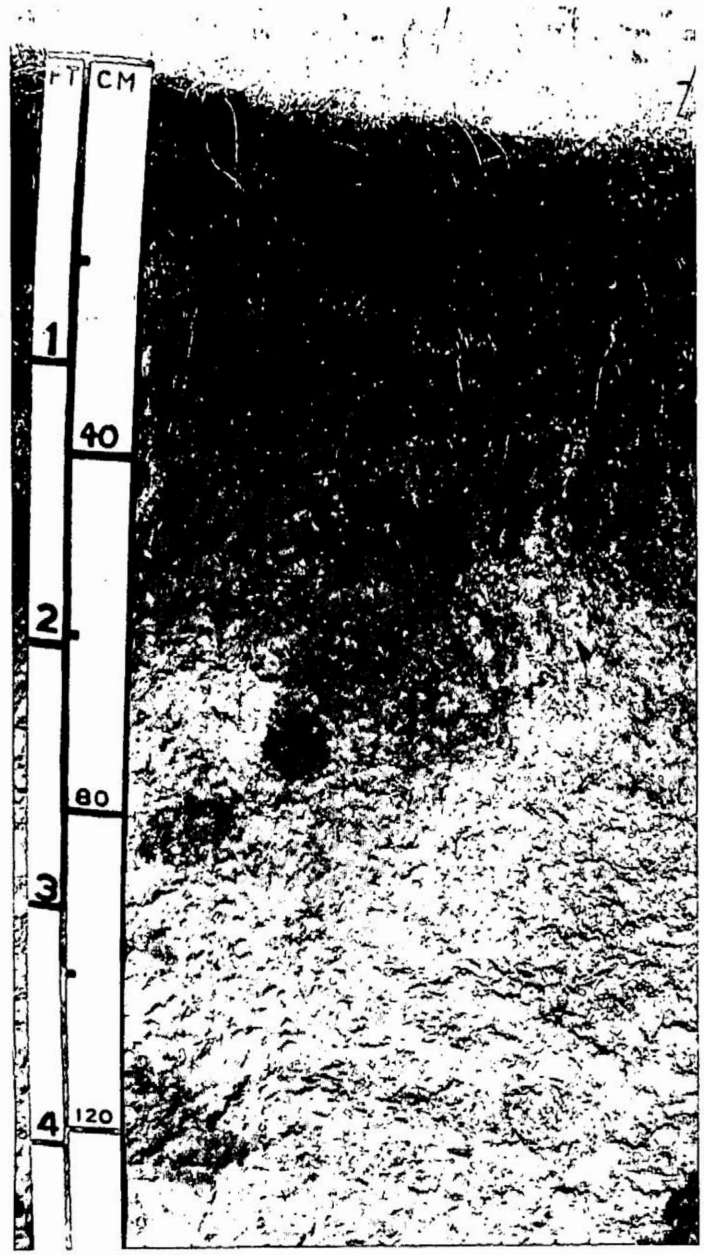


Figure 9.—Typical profile of Walsh loam. The dark-colored circular areas are filled animal burrows.

Typical pedon of Walsh loam in an area of Kloten-Walsh-Edgeley loams, 6 to 35 percent slopes, 450 feet east and 80 feet south of the northwest corner of sec. 27, T. 163 N., R. 59 W.

A—0 to 11 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; neutral; clear smooth boundary.

Bw1—11 to 28 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; slightly acid; clear smooth boundary.

Bw2—28 to 35 inches; very dark grayish brown (2.5Y 3/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, sticky and plastic; common very fine and fine roots; about 10 percent shale gravel; slightly acid; clear smooth boundary.

C—35 to 60 inches; very dark grayish brown (2.5Y 3/2) loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, sticky and plastic; common very fine and fine roots; about 10 percent shale gravel; slightly acid.

The thickness of the mollic epipedon ranges from 22 to 30 inches. The A horizon has value of 2 or 3. The Bw horizon has value of 2 to 4. It is loam or clay loam. The C horizon has value of 3 to 5 (5 to 7 when dry). It is loam, gravelly loam, or clay loam. Some pedons have a gravelly loamy sand 2C horizon within a depth of 40 to 60 inches. The Walsh soil in map unit 34B has moderate permeability in the upper part and very rapid permeability in the lower part.

Waukon Series

The Waukon series consists of deep, well drained, moderately permeable soils on till plains, some of which are dissected (fig. 10). These soils formed in glacial till. Slope ranges from 0 to 9 percent.

Typical pedon of Waukon loam, 3 to 6 percent slopes, 1,875 feet east and 1,300 feet north of the southwest corner of sec. 36, T. 159 N., R. 57 W.

Oe—1 inch to 0; partially decayed mat of leaves, twigs, and roots.

A—0 to 3 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; strong fine and very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and medium roots; about 5 percent gravel and 5 percent cobblestones; neutral; clear wavy boundary.

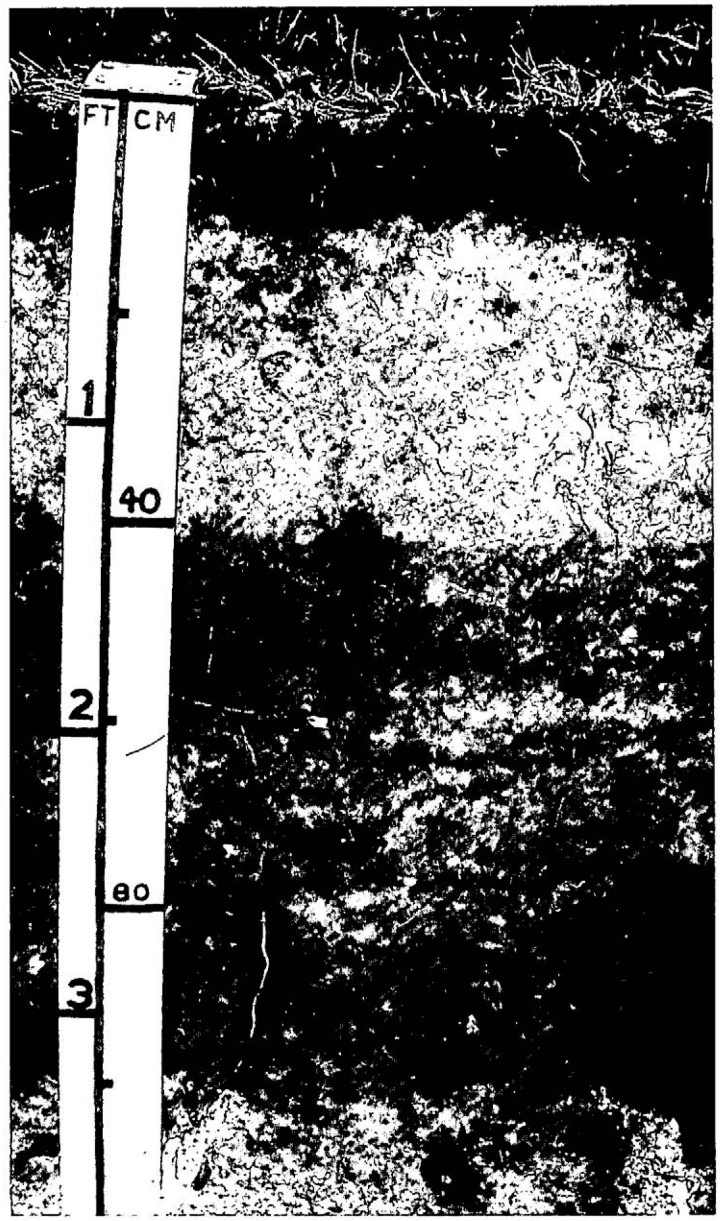


Figure 10.—Typical profile of Waukon loam.

E—3 to 9 inches; very dark gray (10YR 3/1) loam, gray (10YR 6/1) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; few very fine pores; about 5 percent gravel and 10 percent cobblestones; neutral; clear wavy boundary.

B/E—9 to 13 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) (B) dry, light gray (10YR 7/2) (E) dry; moderate fine and

medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; uncoated sand grains on faces of peds; about 5 percent gravel and 10 percent cobblestones; neutral; clear wavy boundary.

Bt1—13 to 23 inches; dark grayish brown (10YR 4/2) clay loam, faces of peds are grayish brown (10YR 5/2) dry and interior of peds is dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) dry; moderate coarse prismatic structure parting to moderate coarse angular blocky; hard, friable, sticky and plastic; common fine and medium roots; many distinct clay films on faces of peds; about 5 percent gravel; neutral; gradual wavy boundary.

Bt2—23 to 40 inches; very dark grayish brown (10YR 3/2) clay loam, faces of peds are grayish brown (10YR 5/2) dry and interior of peds is dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) dry; moderate coarse prismatic structure parting to weak medium angular blocky; hard, friable, sticky and plastic; common fine and medium roots; common distinct clay films on faces of peds and as bridges between sand grains; about 5 percent gravel; mildly alkaline; clear wavy boundary.

C1—40 to 51 inches; dark grayish brown (2.5Y 4/2) loam, light gray (2.5Y 7/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common soft masses and filaments of lime; slightly effervescent; mildly alkaline; gradual wavy boundary.

C2—51 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few soft masses of lime; slightly effervescent; mildly alkaline.

The depth to lime ranges from 34 to 47 inches. The A horizon has value of 2 or 3 (4 or 5 when dry). The E horizon has chroma of 1 or 2. As a result of tillage, some pedons do not have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (6 or 7 when dry), and chroma of 2 to 4. The C horizon has value of 4 or 5 and chroma of 2 to 4. It is loam or clay loam.

Wyard Series

The Wyard series consists of deep, somewhat poorly drained, moderately permeable soils on till plains. These soils formed in alluvium and glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Wyard loam in an area of Wyard-Hamerly loams, 0 to 3 percent slopes, 300 feet west and 1,750 feet north of the southeast corner of sec. 16, T. 163 N., R. 64 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; mildly alkaline; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; few fine faint dark brown (10YR 3/3) mottles; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

Bw—14 to 21 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; few fine prominent reddish brown (5YR 4/4) mottles and common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine manganese concretions; neutral; gradual smooth boundary.

Bk—21 to 29 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; few fine prominent dark yellowish brown (10YR 4/4) and reddish brown (5YR 4/4) mottles and few large distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—29 to 41 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; few fine prominent very dark gray (10YR 3/1) and reddish brown (5YR 4/4) mottles and common fine distinct dark grayish brown (2.5Y 4/2) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—41 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; few fine prominent reddish brown (5YR 4/4) mottles, common medium prominent gray (10YR 5/1) mottles, and common fine distinct light olive brown (2.5Y 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 10 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 22 inches. The depth to lime ranges from 21 to 43 inches.

The A horizon has value of 3 or 4 when dry. Some pedons have uncoated silt and sand grains on the faces of peds in the lower part of the A horizon. The Bw horizon has hue of 2.5Y or 10YR, value of 3 or 4 (4 to 6 when dry), and chroma of 1 or 2. It is loam or silt loam. The Bk horizon has value of 7 or 8 when dry and chroma of 2 to 4. It is loam or silt loam. The C horizon has value of 5 or 6 (6 or 7 when dry). It is loam or clay loam.

Formation of the Soils

This section relates the factors of soil formation to the formation of soils in Cavalier County.

Soil forms through processes acting on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rock and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in Cavalier County formed mostly in glacial drift. The advancing glaciers picked up rocks and soil material, ground and mixed them, and deposited the material as the ice melted from the receding glacier. Some soils, such as those of the Barnes and Svea series, formed in unsorted material, or glacial till. Some soils, such as those of the Hegne and Glyndon series, formed in glaciolacustrine deposits, or glacial material deposited by water in glacial lakes. Other soils, such as those of the Sioux and Fordville series, formed in glacial outwash, or material deposited by glacial meltwater. Some soils, such as those of the Edgeley and Kloten series, formed partially in shale in areas where streams dissected the till plain. Other soils, such as those of the Cashel and Fairdale series, formed in alluvium, or material recently deposited by streams.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of soil material. The climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soil.

In addition to weathering soil material, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Freezing and thawing help to break down soil particles in the parent material, thereby providing more surface area for chemical processes. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Cavalier County has a subhumid climate characterized by cool winters and warm summers. The more significant features of this climate are the amount and seasonal distribution of precipitation, seasonal temperatures, and length of the frost-free season. The relatively short summers—100 to 125 frost-free days—are reasonably warm and are characterized by abundant sunshine during the growing season. In comparison, the winters are relatively long and are characterized by frequent temperature fluctuations. Cold airmasses causing strong gusty winds result in a high chill factor rating.

Annual precipitation for the county ranges from 17 to 20 inches. Approximately 80 percent of this precipitation falls during the warmer season; this, combined with the latitude of the county, which results in long days of sunshine during the growing season, has a significant effect on the high agricultural productivity of the area.

The high agricultural productivity of the county has a

direct influence on the soil forming factors. The land is often left bare because of the agriculture practices used. Vegetation therefore is not allowed to continually be a soil forming factor. Erosion can remove tons of topsoil and in the process destroy thousands of years of soil development.

Plant and Animal Life

The soils in Cavalier County formed mainly under grassland vegetation, but some formed under woodland vegetation. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soil. The fibrous roots of these grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result of these changes in the soil, less water runs off the surface and more moisture is available for increased microbiological activity. The decay of the plants improves the available water capacity, tilth, and fertility of the soil. The decayed organic matter, accumulating over long periods, gives the surface layer its dark color.

Kelvin, Olga, and Waukon soils formed under woodland vegetation. These soils were subject to a greater amount of leaching than other soils. The leaching has resulted in the removal of clay from the surface layer and its subsequent accumulation in the subsoil.

Micro-organisms have important effects on soil formation because they feed on undecomposed organic matter and convert it into humus from which plants can obtain nutrients for increased growth. Bacteria and different kinds of fungi attack leaves and other forms of organic matter. Insects, earthworms, and small burrowing animals help to mix the humus with the soil.

Human activities greatly affect soil formation. Proper management practices can alter soil drainage. They can also help to control erosion, thus maintaining fertility. Poor management can increase the susceptibility of the soil to erosion and thus make it unproductive.

Relief

The slope of the soils in Cavalier County ranges from level to very steep. The degree of slope and the shape of the surface affect each soil through their effects on runoff and internal drainage.

On Buse soils and others in areas where slopes are steep, much of the precipitation is lost as runoff. Vegetation is sparse, leaching is restricted, and profile development is slow. Svea soils and others in the lower lying areas receive more moisture because of their position on the landscape. As a result, plant growth, leaching, and profile development are increased.

Soils that formed in depressions vary widely in profile development, depending on the degree of wetness. Parnell and Tonka soils, which are in the shallower depressions, exhibit an advanced degree of horizonation because of the alternate wetting and drying cycles that occur in these areas. Southam soils, which are in the deeper depressions, are continuously wet and have a very thick surface soil. The horizonation in these soils is a result of sedimentary processes rather than soil forming processes *(4)*.

Time

The formation of a soil is a very slow process. Much time is required for the processes of soil formation to act on the parent material and to form distinct horizons within the soil profile. Approximately 10,000 years has passed since the glacier receded from Cavalier County. In geologic terms, the soils in the county are young.

More time has been available for the formation of the Svea soils on glacial till plains than for the formation of the Fairdale soils on flood plains. Because of the position of the flood plains and the flooding, the forces of soil formation have not been able to work continually on the Fairdale soils. Flooding has not allowed vegetation to be active in the formation of these soils. Svea soils have well defined horizons, whereas Fairdale soils do not.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between

trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils commonly are very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils commonly are medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils commonly are level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along

the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as a pH value, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Root shearing. The cutting, tearing, and disruption of plant roots caused by animals grazing when the soil is wet and soft.

Root zone. The part of the soil that can be penetrated by plant roots.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Generally, the E horizon. If this horizon is at the surface, it is called a surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. An A horizon 10 inches or less in thickness. Commonly designated as the "plow layer" or "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their usefulness and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam,*

silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Langdon exp. farm, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	9.9	-10.1	-.1	39	-37	0	0.58	0.21	0.89	3	7.0
February----	18.1	-3.5	7.3	41	-33	0	.42	.14	.65	2	5.0
March-------	30.2	8.8	19.5	56	-28	24	.72	.24	1.10	3	6.7
April-------	50.0	27.0	38.5	82	-1	138	1.31	.44	2.04	4	4.4
May---------	66.3	38.4	52.4	89	19	400	2.42	.94	3.66	6	.9
June--------	74.6	48.7	61.7	94	31	651	2.99	1.80	4.05	7	.0
July--------	79.7	53.1	66.4	97	38	818	2.93	1.46	4.20	6	.0
August------	78.6	51.0	64.8	96	34	769	3.04	1.31	4.51	6	.0
September---	67.5	40.9	54.2	92	22	426	1.95	.75	2.95	5	.0
October-----	55.1	31.0	43.1	82	11	186	1.14	.43	1.73	3	1.7
November----	33.5	15.0	24.3	62	-15	15	.64	.18	1.00	2	5.8
December----	17.5	-1.1	8.2	42	-32	0	.51	.17	.77	2	5.7
Yearly:											
Average---	48.4	26.2	36.7	---	---	---	---	---	---	---	---
Extreme---	---	---	---	98	-37	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,427	18.65	15.27	21.86	49	37.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Langdon exp. farm, North Dakota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 20	May 31	June 17
2 years in 10 later than--	May 15	May 25	June 10
5 years in 10 later than--	May 4	May 15	May 29
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 16	Sept. 8	Aug. 17
2 years in 10 earlier than--	Sept. 22	Sept. 12	Aug. 24
5 years in 10 earlier than--	Oct. 4	Sept. 22	Sept. 7

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Langdon exp. farm, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	128	106	67
8 years in 10	136	114	79
5 years in 10	152	129	100
2 years in 10	167	145	122
1 year in 10	175	153	133

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Southam clay	9,440	1.0
2	Vallers, saline-Parnell complex	59,720	6.2
3	Parnell silt loam	8,220	0.8
4	Easby clay loam	5,340	0.6
5	Manfred-Vallers, saline, silty clay loams	5,120	0.5
6	La Prairie loam	1,010	0.1
7	Fairdale loam, channeled	3,580	0.4
8	Lamoure silt loam	4,270	0.4
10	Svea-Barnes loams, 0 to 3 percent slopes	46,030	4.8
10B	Svea-Barnes loams, 3 to 6 percent slopes	27,710	2.9
11B	Svea-Buse loams, 3 to 6 percent slopes	85,710	8.9
11C	Svea-Buse loams, 6 to 9 percent slopes	18,930	2.0
11D	Buse-Svea loams, 9 to 15 percent slopes	3,110	0.3
11E	Buse-Svea loams, 15 to 35 percent slopes	2,900	0.3
12B	Barnes-Buse loams, 3 to 6 percent slopes	34,550	3.6
14	Divide loam, 1 to 3 percent slopes	2,270	0.2
15	Wyard-Hamerly loams, 0 to 3 percent slopes	41,730	4.3
16	Hamerly-Tonka loams, 0 to 3 percent slopes	251,190	26.0
17	Vallers-Hamerly loams, saline, 0 to 3 percent slopes	54,890	5.7
19	Hamerly-Cresbard loams, 1 to 3 percent slopes	51,350	5.3
20	Cresbard-Svea loams, 1 to 3 percent slopes	45,110	4.7
20B	Cresbard-Svea loams, 3 to 6 percent slopes	19,180	2.0
21	Cavour-Cresbard loams, 0 to 3 percent slopes	30,200	3.1
22	Miranda-Cavour loams	3,900	0.4
23B	Mekinock loam, 0 to 6 percent slopes	710	0.1
25	Hattie clay, 1 to 3 percent slopes	1,920	0.2
26	Rolette clay loam, 1 to 3 percent slopes	4,690	0.5
26B	Rolette clay loam, 3 to 6 percent slopes	4,170	0.4
26C	Rolette silty clay loam, 6 to 9 percent slopes	940	0.1
27D	Olga silty clay loam, 9 to 15 percent slopes	1,390	0.1
27E	Olga silty clay loam, 15 to 35 percent slopes	7,720	0.8
30F	Kloten-Walsh-Edgeley loams, 6 to 35 percent slopes	11,990	1.0
31C	Binford sandy loam, 1 to 9 percent slopes	1,330	0.1
32	Brantford loam, 0 to 3 percent slopes	3,850	0.4
33	Vang loam, 0 to 3 percent slopes	3,060	0.3
33B	Vang-Coe complex, 3 to 6 percent slopes	5,830	0.6
33C	Vang-Coe complex, 6 to 9 percent slopes	1,520	0.2
34	Walsh-Vang loams, 0 to 3 percent slopes	8,450	0.9
34B	Walsh, sand substratum-Vang loams, 3 to 6 percent slopes	890	0.1
35	Inkster loam, 0 to 3 percent slopes	2,070	0.2
36B	Maddock loamy fine sand, 1 to 6 percent slopes	1,470	0.2
36E	Maddock loamy fine sand, 9 to 35 percent slopes	1,230	0.1
37	Arveson loam	510	0.1
38	Hegne silty clay	2,970	0.3
39	Hegne silty clay, saline	1,910	0.2
40	Glyndon silt loam	390	*
41	Kelvin loam, 0 to 3 percent slopes	2,980	0.3
42	Suomi-Kelvin complex, 0 to 3 percent slopes	7,430	0.8
44	Waukon loam, 0 to 3 percent slopes	13,620	1.4
44B	Waukon loam, 3 to 6 percent slopes	13,990	1.4
44C	Waukon loam, 6 to 9 percent slopes	2,250	0.2
46F	Olga-Kloten complex, 9 to 120 percent slopes	26,320	2.7
48	Cashel silty clay	2,170	0.2
49C	Fordville-Sioux complex, 3 to 9 percent slopes	2,040	0.2
51	Colvin silty clay loam	4,420	0.5
53	Hamar loamy fine sand	520	0.1
55	Roliss silt loam	6,620	0.7
57	Pits	230	*
	Water	1,260	0.1
	Total	968,320	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

(Yields generally are those that can be expected under a high level of management. For poorly drained and very poorly drained soils, however, the yields are those expected in undrained areas. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
1. Southam					
2 Vallers-Parnell	14	23	7	700	2.5
3 Parnell	8	13	4	400	2.8
4 Easby	---	---	---	---	1.5
5 Manfred-Vallers	---	---	---	---	1.8
6 La Prairie	38	62	19	1,900	2.8
7 Fairdale	---	---	---	---	2.8
8 Lamoure	16	26	8	800	2.8
10 Svea-Barnes	36	59	18	1,800	2.7
10B Svea-Barnes	34	55	17	1,700	2.7
11B Svea-Buse	28	46	14	1,400	2.2
11C Svea-Buse	22	36	11	1,100	2.0
11D Buse-Svea	---	---	---	---	1.8
11E Buse-Svea	---	---	---	---	1.8
12B Barnes-Buse	26	42	13	1,300	2.0
14 Divide	26	42	13	1,300	2.3
15 Wyard-Hamerly	34	55	17	1,700	2.6
16 Hamerly-Tonka	26	42	13	1,300	2.5
17 Vallers-Hamerly	14	23	7	700	2.1
19 Hamerly-Cresbard	32	52	16	1,600	1.9

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
20----------------------- Cresbard-Svea	32	52	16	1,600	2.1
20B---------------------- Cresbard-Svea	28	46	14	1,400	2.2
21----------------------- Cavour-Cresbard	20	33	10	1,000	1.5
22----------------------- Miranda-Cavour	---	---	---	---	1.1
23B---------------------- Mekinock	---	---	---	---	0.9
25----------------------- Hattie	34	55	17	1,700	2.2
26----------------------- Rolette	34	55	17	1,700	2.2
26B---------------------- Rolette	30	49	15	1,500	2.2
26C---------------------- Rolette	24	39	12	1,200	2.2
27D---------------------- Olga	16	26	8	800	2.6
27E. Olga					
30F. Kloten-Walsh-Edgeley					
31C---------------------- Binford	14	23	7	700	1.8
32----------------------- Brantford	20	33	10	1,000	1.8
33----------------------- Vang	24	39	12	1,200	2.6
33B---------------------- Vang-Coe	18	29	9	900	1.4
33C---------------------- Vang-Coe	16	26	8	800	1.4
34----------------------- Walsh-Vang	34	55	17	1,700	2.6
34B---------------------- Walsh-Vang	30	49	15	1,500	2.6
35----------------------- Inkster	28	46	14	1,400	2.1
36B---------------------- Maddock	16	26	8	800	1.8

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Spring wheat	Barley	Flax	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Lbs	Tons
36E. Maddock					
37 Arveson	14	23	7	700	2.8
38 Hegne	30	49	15	1,500	2.8
39 Hegne	14	23	7	700	2.1
40 Glyndon	34	55	17	1,700	2.3
41 Kelvin	34	55	17	1,700	2.6
42 Suomi-Kelvin	32	52	16	1,600	2.7
44 Waukon	34	55	17	1,700	2.6
44B Waukon	32	52	16	1,600	2.6
44C Waukon	24	39	12	1,200	2.6
46F. Olga-Kloten					
48 Cashel	34	55	17	1,700	2.8
49C Fordville-Sioux	16	26	8	800	1.8
51 Colvin	8	13	4	400	2.8
53 Hamar	10	17	5	500	2.8
55 Roliss	8	13	4	400	2.8
57*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
2*:				
Vallers	Saline Lowland	3,200	2,800	2,400
Parnell	Wetland	6,300	5,700	4,600
3 Parnell	Wetland	6,300	5,700	4,600
4 Easby	Saline Lowland	3,200	2,800	2,400
5*:				
Manfred	Saline Lowland	3,200	2,800	2,400
Vallers	Saline Lowland	3,200	2,800	2,400
7 Fairdale	Overflow	3,500	3,100	2,700
11D*, 11E*:				
Buse	Thin Upland	2,400	2,100	1,600
Svea	Silty	2,800	2,400	2,100
17*:				
Vallers	Saline Lowland	3,200	2,800	2,400
Hamerly	Saline Lowland	3,200	2,800	2,400
22*:				
Miranda	Thin Claypan	1,100	900	700
Cavour	Claypan	2,000	1,800	1,500
23B Mekinock	Thin Claypan	1,100	900	700
30F*:				
Kloten	Shallow	1,900	1,700	1,400
Walsh	Silty	2,800	2,400	2,100
Edgeley	Silty	3,100	2,700	2,500
51 Colvin	Wetland	6,200	5,700	5,200

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1. Southam					
2*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian olive.	---	---
Parnell	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Amur honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
3 Parnell	American plum	Eastern redcedar, redosier dogwood, Siberian peashrub, common chokecherry, lilac, Amur honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
4. Easby					
5*: Manfred.					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian olive.	---	---
6 La Prairie	---	Ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
7. Fairdale					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
8: Lamoure	American plum.	Eastern redcedar, redosier dogwood, Siberian peashrub, Amur honeysuckle, common chokecherry, lilac.	Green ash, Black Hills spruce, Manchurian crabapple.	Golden willow.	Eastern cottonwood.
10*, 10B*: Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow.	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
11B*: Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow.	Eastern cottonwood.
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
11C*: Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, Amur honeysuckle, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
11D*:					
Buse.					
Svea	---	Lilac, Siberian peashrub, redosier dogwood, eastern redcedar, Amur honeysuckle, American plum.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
11E*:					
Buse.					
Svea.					
12B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
14 Divide	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
15*:					
Wyard	---	Amur honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
15*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
16*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
17*:					
Vallers	Siberian peashrub, silver buffaloberry.	---	Siberian elm, green ash, Russian olive.	---	---
Hamerly	Silver buffaloberry, Siberian peashrub.	---	Russian olive, green ash, Siberian elm.	---	---
19*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
19*:					
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
20*, 20B*:					
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
21*:					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
22*:					
Miranda.					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
23B.					
Mekinock					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
25: Hattie	American plum, lilac, honeysuckle, late lilac.	Eastern redcedar, Manchurian crabapple, Persian lilac, Siberian peashrub, common chokecherry, birchleaf buckthorn, sargent crabapple, silver buffaloberry.	Green ash, Russian olive, Austrian pine, black locust, bur oak, hackberry, thornless honeylocust.	Siberian elm	Eastern cottonwood, silver maple.
26, 26B, 26C: Rolette	---	Silver buffaloberry, Peking cotoneaster, Russian olive, eastern redcedar, lilac, common chokecherry, Siberian peashrub, Amur honeysuckle.	Siberian elm, Siberian crabapple, green ash, ponderosa pine.	---	---
27D: Olga	---	Lilac, silver buffaloberry, Russian olive, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub, Amur honeysuckle.	Siberian elm, Siberian crabapple, green ash, ponderosa pine.	---	---
27E. Olga					
30F*: Kloten.					
Walsh	---	Peking cotoneaster, redosier dogwood, American plum, Amur honeysuckle, Siberian peashrub, eastern redcedar, common chokecherry, ponderosa pine.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
30F*:					
Edgeley	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Bur oak, Siberian crabapple, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
31C Binford	Siberian peashrub, Amur honeysuckle, silver buffaloberry, lilac.	Siberian crabapple, Rocky Mountain juniper, green ash, Russian olive, eastern redcedar, common chokecherry.	Ponderosa pine	---	---
32 Brantford	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
33 Vang	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
33B*, 33C*:					
Vang	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
Coe.					
34*:					
Walsh	---	Peking cotoneaster, redosier dogwood, American plum, Amur honeysuckle, Siberian peashrub, eastern redcedar, common chokecherry, ponderosa pine.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
34*:					
Vang	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
34B*:					
Walsh	---	Amur honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Vang	Lilac, Siberian peashrub, Amur honeysuckle, silver buffaloberry.	Siberian crabapple, green ash, Russian olive, common chokecherry, eastern redcedar, Rocky Mountain juniper.	Ponderosa pine	---	---
35 Inkster	---	Peking cotoneaster, redosier dogwood, Amur honeysuckle, American plum, Siberian peashrub, eastern redcedar, common chokecherry, ponderosa pine.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
36B Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Amur honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian olive.	---	---
36E. Maddock					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
37: Arveson	American plum	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
38: Hegne	American plum	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
39: Hegne	Siberian peashrub, silver buffaloberry.	---	Green ash, Russian olive, Siberian elm.	---	---
40: Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
41: Kelvin	---	American plum, eastern redcedar, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian olive.	---	---
42*: Suomi	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
42*:					
Kelvin	---	American plum, eastern redcedar, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce, Russian olive.	---	---
44, 44B, 44C Waukon	---	Redosier dogwood, Siberian peashrub, Amur honeysuckle, eastern redcedar, American plum, lilac.	Ponderosa pine, green ash, Black Hills spruce, Russian olive, bur oak, Siberian crabapple.	---	---
46F*:					
Olga.					
Kloten.					
48 Cashel	---	Redosier dogwood, ponderosa pine, Peking cotoneaster, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
49C*:					
Fordville	Siberian peashrub, Amur honeysuckle, silver buffaloberry, lilac.	Rocky Mountain juniper, green ash, Siberian crabapple, common chokecherry, Russian olive, eastern redcedar.	Ponderosa pine	---	---
Sioux.					
51 Colvin	---	American plum, Siberian peashrub, Amur honeysuckle, eastern redcedar, redosier dogwood, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood, Siberian elm.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
53. Hamar	American plum	Amur honeysuckle, redosier dogwood, common chokecherry, Siberian peashrub, lilac.	Black Hills spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow	Eastern cottonwood.
55. Roliss	American plum	Amur honeysuckle, redosier dogwood, common chokecherry, Siberian peashrub, lilac.	Black Hills spruce, green ash, Siberian crabapple, eastern redcedar.	Golden willow	Eastern cottonwood.
57*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1-------------------- Southam	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
2*:				
Vallers--------------	Severe: wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
Parnell--------------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
3-------------------- Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
4-------------------- Easby	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
5*:				
Manfred--------------	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding, excess sodium.	Severe: ponding.
Vallers--------------	Severe: wetness.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
6-------------------- La Prairie	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
7-------------------- Fairdale	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
8-------------------- Lamoure	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
10*:				
Svea-----------------	Slight---------------	Slight---------------	Moderate: small stones.	Slight.
Barnes---------------	Slight---------------	Slight---------------	Slight---------------	Slight.
10B*:				
Svea-----------------	Slight---------------	Slight---------------	Moderate: slope, small stones.	Slight.
Barnes---------------	Slight---------------	Slight---------------	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
11B*:				
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
11C*:				
Svea	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
11D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Svea	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
11E*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
12B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
14 Divide	Slight	Slight	Moderate: slope.	Slight.
15*:				
Wyard	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
16*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
17*:				
Vallers	Severe: wetness, excess humus.	Severe: wetness, excess humus, excess salt.	Severe: excess humus, wetness, excess salt.	Severe: wetness, excess humus.
Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
19*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
20*, 20B*:				
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
21*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
22*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
23B Mekinock	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
25 Hattie	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
26, 26B Rolette	Slight	Slight	Moderate: slope.	Slight.
26C Rolette	Slight	Slight	Severe: slope.	Slight.
27D Olga	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
27E Olga	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
30F*:				
Kloten	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Moderate: slope.
Walsh	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Edgeley	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
31C Binford	Slight	Slight	Moderate: slope.	Slight.
32 Brantford	Slight	Slight	Moderate: small stones.	Slight.
33 Vang	Slight	Slight	Slight	Slight.
33B*:				
Vang	Slight	Slight	Moderate: slope.	Slight.
Coe	Severe: small stones.	Severe: small stones.	Severe: small stones.	Slight.
33C*:				
Vang	Slight	Slight	Severe: slope.	Slight.
Coe	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Slight.
34*:				
Walsh	Slight	Slight	Moderate: small stones.	Slight.
Vang	Slight	Slight	Slight	Slight.
34B*:				
Walsh	Slight	Slight	Moderate: slope, small stones.	Slight.
Vang	Slight	Slight	Moderate: slope.	Slight.
35 Inkster	Slight	Slight	Slight	Slight.
36B Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
36E Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
37 Arveson	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
38 Hegne	Severe: wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.
39 Hegne	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.
40 Glyndon	Slight	Slight	Slight	Slight.
41 Kelvin	Slight	Slight	Slight	Slight.
42*:				
Suomi	Slight	Slight	Slight	Slight.
Kelvin	Slight	Slight	Slight	Slight.
44 Waukon	Slight	Slight	Slight	Slight.
44B Waukon	Slight	Slight	Moderate: slope.	Slight.
44C Waukon	Slight	Slight	Severe: slope.	Slight.
46F*:				
Olga	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
Kloten	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Slight.
48 Cashel	Severe: flooding, wetness.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.
49C*:				
Fordville	Slight	Slight	Severe: slope.	Slight.
Sioux	Moderate: small stones.	Slight	Severe: slope, small stones.	Slight.
51 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
53 Hamar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
55-------------------- Roliss	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
57*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1----------------- Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
2*:									
Vallers-----------	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
Parnell-----------	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
3----------------- Parnell	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
4----------------- Easby	Poor	Poor	Very poor	Very poor	Good	Good	Poor	Good	Very poor.
5*:									
Manfred-----------	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
Vallers-----------	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
6----------------- La Prairie	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
7----------------- Fairdale	Poor	Poor	Fair	Good	Poor	Poor	Poor	Poor	Good.
8----------------- Lamoure	Poor	Poor	Fair	Fair	Fair	Fair	Poor	Fair	Fair.
10*:									
Svea--------------	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
10B*:									
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Barnes------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
11B*:									
Svea--------------	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse--------------	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
11C*:									
Svea--------------	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Buse--------------	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
11D*:									
Buse--------------	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Svea--------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
11E*:									
Buse--------------	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
11E*:									
Svea	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
12B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
14 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
15*:									
Wyard	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good.
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
16*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
17*:									
Vallers	Fair	Fair	Very poor	Fair	Good	Good	Fair	Good	Poor.
Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
19*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
20*:									
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
20B*:									
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
21*:									
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
Cresbard	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
22*:									
Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
23B Mekinock	Very poor	Very poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor	Very poor.
25 Hattie	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
26, 26B, 26C Rolette	Good	Good	Good	Poor	Poor	Poor	Good	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
27D Olga	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
27E Olga	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Fair.
30F*:									
Kloten	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Walsh	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
Edgeley	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
31C Binford	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
32 Brantford	Fair	Fair	Good	Poor	Poor	Poor	Fair	Very poor	Fair.
33 Vang	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
33B*, 33C*:									
Vang	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Coe	Poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Fair.
34*:									
Walsh	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
Vang	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
34B*:									
Walsh	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
Vang	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
35 Inkster	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
36B Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
36E Maddock	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
37 Arveson	Good	Good	Fair	Fair	Good	Good	Fair	Good	Fair.
38 Hegne	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
39 Hegne	Fair	Fair	Fair	Very poor	Poor	Good	Fair	Fair	Poor.
40 Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
41 Kelvin	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
42*:									
Suomi	Good	Good	Good	Poor	Fair	Fair	Good	Fair	Good.
Kelvin	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
44, 44B Waukon	Good	Good	Good	---	Poor	Very poor	Good	Very poor	---
44C Waukon	Good	Good	Good	---	Very poor	Very poor	Good	Very poor	---
46F*:									
Olga	Poor	Fair	Good	Good	Very poor	Very poor	Fair	Very poor	Fair.
Kloten	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
48 Cashel	Good	Good	Fair	Good	Poor	Fair	Good	Poor	Fair.
49C*:									
Fordville	Poor	Good	Good	Fair	Very poor	Very poor	Poor	Very poor	Good.
Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
51 Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
53 Hamar	Poor	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
55 Roliss	Good	Good	Fair	---	Very poor	Poor	Good	Very poor	---
57*. Pits									

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1: Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
2*:					
Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
3: Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
4: Easby	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
5*:					
Manfred	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
6: La Prairie	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength.
7: Fairdale	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
8: Lamoure	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
10*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
10B*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
11B*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
11C*:					
Svea	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
11D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Svea	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
11E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
12B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
14 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
15*:					
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
15*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
16*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka------------	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
17*:					
Vallers----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
19*:					
Hamerly----------	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
20*:					
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
20B*:					
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Svea-------------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope.	Severe: low strength.
21*:					
Cavour-----------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Cresbard---------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
22*:					
Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
23B Mekinock	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
25 Hattie	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
26, 26B, 26C Rolette	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
27D Olga	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
27E Olga	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.
30F*:					
Kloten	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Walsh	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Edgeley	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
31C Binford	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
32 Brantford	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
33 Vang	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
33B*, 33C*:					
Vang	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Coe	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
34*:					
Walsh	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
34*:					
Vang	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
34B*:					
Walsh	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, frost action.
Vang	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
35 Inkster	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
36B Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
36E Maddock	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
37 Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
38 Hegne	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.
39 Hegne	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
40 Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
41 Kelvin	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
42*:					
Suomi	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.
Kelvin	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
44 Waukon	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.
44B, 44C Waukon	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
46F*:					
Olga	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.
Kloten	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
48 Cashel	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength.
49C*:					
Fordville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Sioux	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
51 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
53 Hamar	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
55 Roliss	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
57*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
3 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
4 Easby	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess salt.	Severe: wetness.	Poor: hard to pack, wetness, excess salt.
5*:					
Manfred	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess sodium.	Severe: ponding.	Poor: hard to pack, ponding, excess sodium.
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
6 La Prairie	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Good.
7 Fairdale	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
8 Lamoure	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
10*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
10B*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
11B*:					
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
11C*:					
Svea	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
11D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Svea	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
11E*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Svea	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
12B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
14 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
15*:					
Wyard	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
15*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
16*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
17*:					
Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
19*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
20*, 20B*:					
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
21*:					
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
22*:					
Miranda	Severe: wetness, percs slowly.	Slight	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
23B----------------- Mekinock	Severe: thin layer, seepage, percs slowly.	Severe: seepage.	Severe: seepage, too clayey, excess sodium.	Moderate: seepage.	Poor: area reclaim, too clayey, hard to pack.
25------------------ Hattie	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
26, 26B------------- Rolette	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
26C----------------- Rolette	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
27D----------------- Olga	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
27E----------------- Olga	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
30F*:					
Kloten-------------	Severe: seepage, thin layer, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: thin layer, slope, area reclaim.
Walsh--------------	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: hard to pack.
Edgeley------------	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage, slope.	Poor: area reclaim, hard to pack.
31C----------------- Binford	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
32------------------ Brantford	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
33------------------ Vang	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
33B*:					
Vang---------------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
33B*:					
Coe	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
33C*:					
Vang	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
Coe	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
34*:					
Walsh	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Poor: hard to pack.
Vang	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
34B*:					
Walsh	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Slight	Fair: too clayey, small stones.
Vang	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, small stones.
35 Inkster	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
36B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36E Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
37 Arveson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
38 Hegne	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
39 Hegne	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
40 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
41 Kelvin	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
42*:					
Suomi	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Kelvin	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
44 Waukon	Moderate: percs slowly.	Moderate: seepage, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
44B Waukon	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Moderate: too clayey.	Slight	Fair: too clayey.
44C Waukon	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
46F*:					
Olga	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
Kloten	Severe: seepage, thin layer.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: thin layer, area reclaim.
48 Cashel	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: too clayey, hard to pack.
49C*:					
Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
51 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
53------------------ Hamar	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
55------------------ Roliss	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
57*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1: Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
2*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
3: Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
4: Easby	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
5*:				
Manfred	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess sodium.
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
6: La Prairie	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
7: Fairdale	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
8: Lamoure	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
10*, 10B*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
11B*, 11C*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
11D*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
11E*:				
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
12B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
14 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
15*:				
Wyard	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
16*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
17*:				
Vallers	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
19*:				
Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
20*, 20B*:				
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
21*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
22*:				
Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
23B Mekinock	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium, too clayey, excess salt.
25 Hattie	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
26, 26B, 26C Rolette	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
27D------------------- Olga	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
27E------------------- Olga	Poor: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
30F*:				
Kloten---------------	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Walsh----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Edgeley--------------	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
31C------------------- Binford	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
32-------------------- Brantford	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
33-------------------- Vang	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
33B*, 33C*:				
Vang-----------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Coe------------------	Good-----------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
34*:				
Walsh----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Vang-----------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
34B*:				
Walsh----------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Vang-----------------	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
35 Inkster	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
36B Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
36E Maddock	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
37 Arveson	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
38 Hegne	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
39 Hegne	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
40 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
41 Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
42*:				
Suomi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Kelvin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
44, 44B, 44C Waukon	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
46F*:				
Olga	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
Kloten	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
48 Cashel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
49C*:				
Fordville	Good	Probable	Probable	Fair: thin layer.
Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
51: Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
53: Hamar	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
55: Roliss	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
57*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, excess salt.
2*:						
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
3 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
4 Easby	Slight	Severe: piping, hard to pack, wetness.	Frost action, excess salt.	Wetness, droughty, excess salt.	Wetness	Wetness, excess salt, droughty.
5*:						
Manfred	Slight	Severe: ponding, excess sodium.	Ponding, percs slowly, frost action.	Ponding, percs slowly, excess sodium.	Ponding, percs slowly.	Wetness, excess sodium, percs slowly.
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
6 La Prairie	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
7 Fairdale	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Favorable	Favorable.
8 Lamoure	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
10*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
10B*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
11B*:						
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
11C*:						
Svea	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
11D*, 11E*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Svea	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
12B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
14 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
15*:						
Wyard	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
16*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
17*:						
Vallers	Slight	Severe: piping, wetness.	Frost action, excess salt.	Wetness, excess salt.	Wetness	Wetness, excess salt.
Hamerly	Slight	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
19*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
19*:						
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
20*:						
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
20B*:						
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
21*:						
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
22*:						
Miranda	Slight	Severe: excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
23B Mekinock	Moderate: seepage, slope.	Severe: hard to pack, excess sodium.	Deep to water	Slope, percs slowly, thin layer.	Area reclaim, percs slowly.	Excess sodium, area reclaim.
25 Hattie	Slight	Severe: hard to pack.	Deep to water	Slow intake, percs slowly.	Percs slowly	Percs slowly.
26 Rolette	Slight	Severe: hard to pack.	Deep to water	Favorable	Favorable	Favorable.
26B, 26C Rolette	Moderate: slope.	Severe: hard to pack.	Deep to water	Slope	Favorable	Favorable.
27D, 27E Olga	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
30F*:						
Kloten	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
Walsh	Severe: slope.	Severe: piping, hard to pack.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
30F*:						
Edgeley	Severe: slope.	Severe: thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
31C Binford	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
32 Brantford	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, rooting depth.	Large stones, too sandy.	Large stones, droughty.
33 Vang	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
33B*, 33C*:						
Vang	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
Coe	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty.	Large stones, too sandy.	Large stones, droughty.
34*:						
Walsh	Moderate: seepage.	Severe: piping, hard to pack.	Deep to water	Favorable	Erodes easily	Erodes easily.
Vang	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
34B*:						
Walsh	Severe: seepage.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
Vang	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
35 Inkster	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable	Too sandy	Favorable.
36B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
36E Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
37 Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
38 Hegne	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
39 Hegne	Slight	Severe: ponding.	Ponding, percs slowly, excess salt.	Ponding, droughty, slow intake.	Ponding, percs slowly.	Wetness, excess salt, droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
40-----Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness-----	Wetness-----	Favorable.
41-----Kelvin	Slight-----	Moderate: hard to pack.	Deep to water	Favorable-----	Erodes easily	Erodes easily.
42*:						
Suomi-----	Slight-----	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness-----	Percs slowly.
Kelvin-----	Slight-----	Moderate: hard to pack.	Deep to water	Favorable-----	Erodes easily	Erodes easily.
44-----Waukon	Moderate: seepage.	Severe: piping.	Deep to water	Favorable-----	Favorable-----	Favorable.
44B, 44C-----Waukon	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----	Favorable-----	Favorable.
46F*:						
Olga-----	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Kloten-----	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, area reclaim.	Slope, area reclaim.
48-----Cashel	Slight-----	Severe: wetness, hard to pack.	Percs slowly, flooding.	Wetness, slow intake.	Wetness, percs slowly.	Wetness, percs slowly.
49C*:						
Fordville-----	Severe: seepage.	Severe: seepage.	Deep to water	Slope-----	Too sandy-----	Favorable.
Sioux-----	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy-----	Droughty.
51-----Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
53-----Hamar	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
55-----Roliss	Moderate: seepage.	Severe: piping, ponding.	Ponding, frost action.	Ponding-----	Ponding-----	Wetness.
57*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1---------------- Southam	0-27	Clay--------------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	27-44	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	44-60	Silty clay, clay loam, clay.	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
2*:											
Vallers---------	0-11	Loam-------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	11-23	Clay loam, loam, silty clay loam.	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Parnell---------	0-24	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	24-43	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	43-60	Clay loam, silty clay loam.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
3---------------- Parnell	0-24	Silt loam--------	OL, ML	A-4	0	100	100	90-100	70-90	25-40	2-10
	24-43	Clay loam, silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	43-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
4---------------- Easby	0-7	Clay loam--------	CL, CH, MH, ML	A-6, A-7	0-5	95-100	90-100	80-95	60-90	30-55	10-25
	7-60	Clay loam, loam, silty clay loam.	CL, CL-ML, CH, MH	A-4, A-6, A-7	0-5	95-100	90-100	80-95	55-75	25-55	5-25
5*:											
Manfred---------	0-7	Silty clay loam	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-55	15-30
	7-60	Loam, silty clay loam, gravelly clay loam.	CL, CH	A-6, A-7	0	100	80-100	75-100	50-95	25-55	10-35
Vallers---------	0-11	Silty clay loam	OL, CL	A-6, A-7	0	95-100	95-100	95-100	85-95	30-50	10-20
	11-23	Clay loam, loam, silty clay loam.	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
6---------------- La Prairie	0-18	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	85-95	70-80	25-40	5-15
	18-25	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-95	70-80	25-45	5-25
	25-46	Silt loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	85-95	70-80	25-45	5-25
	46-60	Stratified fine sandy loam to silty clay loam.	CL-ML, CL	A-4, A-6, A-7	0	100	95-100	75-95	50-80	25-45	5-25
7---------------- Fairdale	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	3-15
	8-60	Stratified fine sandy loam to silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	95-100	85-100	55-90	20-40	NP-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
8----------------- Lamoure	0-16	Silt loam--------	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	16-38	Silty clay loam, silt loam.	CL, CH, MH, ML	A-7	0	100	100	90-100	85-100	40-70	15-35
	38-60	Stratified sandy loam to silty clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	70-95	35-90	30-50	10-25
10*, 10B*:											
Svea------------	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Barnes----------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
11B*:											
Svea------------	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
Buse------------	0-9	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	9-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
11C*:											
Svea------------	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-50	5-30
Buse------------	0-9	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	9-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
11D*, 11E*:											
Buse------------	0-9	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	9-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
Svea------------	0-14	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-50	5-30
12B*:											
Barnes----------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	8-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
12B*:											
Buse------------	0-9	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-95	55-90	20-35	3-15
	9-60	Loam, clay loam	CL, CL-ML, ML	A-4, A-6, A-7	0	90-100	85-100	70-90	55-85	25-45	5-20
14---------------	0-12	Loam------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
Divide	12-24	Loam, clay loam, gravelly loam.	CL, CL-ML, SM-SC, SC	A-4, A-6, A-7	0-3	95-100	75-100	55-90	35-80	20-45	5-20
	24-60	Stratified loamy sand to very gravelly coarse sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-85	15-65	10-40	5-25	<30	NP-5
15*:											
Wyard-----------	0-21	Loam------------	CL-ML, CL	A-4, A-6	0	95-100	95-100	85-100	60-90	25-40	5-20
	21-60	Loam, silt loam, clay loam.	SM, ML, CL, SC	A-4, A-6, A-7	0-10	95-100	95-100	80-100	35-85	20-45	3-25
Hamerly---------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	8-17	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
16*:											
Hamerly---------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	8-17	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25
Tonka-----------	0-13	Loam------------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	13-31	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	31-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	60-100	50-90	25-50	5-30
17*:											
Vallers---------	0-11	Loam------------	OL, ML	A-4	0	95-100	90-100	80-90	65-80	25-40	3-10
	11-23	Clay loam, loam, silty clay loam.	CL	A-6	0	95-100	90-100	90-95	70-80	30-40	10-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	85-95	60-75	20-40	5-20
Hamerly---------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	8-17	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
19*:											
Hamerly---------	0-8	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	8-17	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	55-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
19*:											
Cresbard	0-8	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-18	Clay loam, clay	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	18-37	Clay loam, silt loam, loam.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	37-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	100	95-100	85-100	60-80	35-55	10-27
20*, 20B*:											
Cresbard	0-8	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-18	Clay loam, clay	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	18-37	Clay loam, silt loam, loam.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	37-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	95-100	100	85-100	60-80	35-55	10-27
Svea	0-14	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	14-21	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-90	20-45	5-25
	21-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-100	60-85	20-50	5-30
21*:											
Cavour	0-9	Loam	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	9-25	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	25-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
Cresbard	0-8	Loam	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	8-18	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	18-37	Clay loam, silt loam, loam.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	37-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	95-100	100	85-100	60-80	35-55	10-27
22*:											
Miranda	0-8	Loam	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	8-15	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	15-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	90-100	85-95	50-80	30-50	10-20
Cavour	0-9	Loam	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	9-25	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	25-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
23B Mekinock	0-2	Loam	CL	A-6, A-7	0	95-100	90-100	85-100	60-75	30-45	10-25
	2-25	Clay, silty clay, clay loam.	CH, CL	A-7	0	95-100	90-100	85-100	70-100	40-75	20-45
	25-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
25 Hattie	0-7	Clay	CH	A-7	0	95-100	90-100	75-100	70-95	50-70	23-43
	7-60	Clay, silty clay	CH	A-7	0	95-100	90-100	75-100	70-95	50-75	23-45
26, 26B Rolette	0-8	Clay loam	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-70	20-45
	8-60	Silty clay, silty clay loam, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-100	35-80	20-50

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
26C--------------- Rolette	0-8	Silty clay loam	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-70	20-45
	8-60	Silty clay, silty clay loam, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-100	35-80	20-50
27D, 27E--------- Olga	0-12	Silty clay loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	75-95	35-70	20-45
	12-50	Silty clay, channery silty clay, clay loam.	CH, CL, MH	A-7, A-6	0-1	95-100	80-100	65-100	50-95	35-70	20-45
	50-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
30F*: Kloten-----------	0-7	Loam--------------	CL, CL-ML	A-4, A-6	0-10	90-100	90-100	85-95	60-90	20-40	5-20
	7-14	Channery loam, loam.	CL-ML, CL	A-4, A-6	0-10	90-100	80-100	70-95	60-90	20-40	5-20
	14-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Walsh------------	0-11	Loam--------------	CL-ML, CL	A-4, A-6	0	95-100	85-100	80-100	60-95	25-40	5-20
	11-60	Loam, gravelly loam, clay loam.	CL-ML, CL, MH	A-4, A-6, A-7	0	95-100	85-100	80-100	60-95	25-60	5-30
Edgeley----------	0-9	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	85-95	60-75	20-40	5-25
	9-27	Loam, channery loam, silt loam.	CL, CH, MH	A-6, A-7	0-5	80-100	75-100	65-95	55-95	25-65	10-40
	27-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
31C--------------- Binford	0-7	Sandy loam--------	SM, ML, SC, CL	A-2, A-4	0	95-100	95-100	60-95	30-55	15-30	NP-10
	7-14	Sandy loam, coarse sandy loam, loam.	SM, ML, SC, CL	A-2, A-4	0	95-100	85-100	60-85	30-60	10-30	NP-10
	14-60	Stratified sand to gravelly coarse sand.	SM, GP-GM, GM, SP-SM	A-1, A-2, A-3	0	50-90	40-85	25-55	5-15	---	NP
32--------------- Brantford	0-15	Loam--------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-90	60-80	20-35	3-15
	15-60	Very gravelly coarse sand, gravelly coarse sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	<35	NP-10
33--------------- Vang	0-11	Loam--------------	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-80	25-45	5-15
	11-27	Loam, clay loam, gravelly loam.	ML, CL, SM, SC	A-4, A-6, A-7	0	65-100	50-100	40-100	35-80	25-45	5-15
	27-60	Very gravelly sand, extremely gravelly loamy sand, gravelly coarse sand.	SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	15-30	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
33B*, 33C*:											
Vang	0-11	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-80	25-45	5-15
	11-27	Loam, clay loam, gravelly loam.	ML, CL, SM, SC	A-4, A-6, A-7	0	65-100	50-100	40-100	35-80	25-45	5-15
	27-60	Very gravelly sand, extremely gravelly loamy sand, gravelly coarse sand.	SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	15-30	---	NP
Coe	0-7	Gravelly loam	SM, GM-GC, SM-SC, GM	A-4, A-2	0-10	50-80	40-70	30-60	25-50	<25	NP-5
	7-60	Very gravelly coarse sand, extremely gravelly loamy coarse sand, gravelly coarse sand.	SM, GP-GM, SP-SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	10-30	---	NP
34*:											
Walsh	0-9	Loam	CL-ML, CL	A-4, A-6	0	95-100	85-100	80-100	60-95	25-40	5-20
	9-60	Loam, gravelly loam, silty clay loam.	CL-ML, CL, MH	A-4, A-6, A-7	0	95-100	85-100	80-100	60-95	25-60	5-30
Vang	0-9	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-80	25-45	5-15
	9-37	Loam, clay loam, gravelly loam.	ML, CL, SM, SC	A-4, A-6, A-7	0	65-100	50-100	40-100	35-80	25-45	5-15
	37-60	Very gravelly sand, extremely gravelly sand.	SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	15-30	---	NP
34B*:											
Walsh	0-9	Loam	CL-ML, CL	A-4, A-6	0	95-100	85-100	80-100	60-95	25-40	5-20
	9-41	Loam, clay loam, gravelly loam.	CL, GC, SC, CL-ML	A-4, A-6	0	65-100	50-100	40-100	35-80	25-40	5-20
	41-60	Gravelly loamy sand, gravelly sand.	SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	15-30	---	NP
Vang	0-12	Loam	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	85-100	60-80	25-45	5-15
	12-35	Loam, clay loam, gravelly loam.	ML, CL, SM, SC	A-4, A-6, A-7	0	65-100	50-100	40-100	35-80	25-45	5-15
	35-60	Very gravelly sand, extremely gravelly sand, gravelly loamy sand.	SM, GM	A-1, A-2	5-25	50-95	30-75	15-60	15-30	---	NP
35 Inkster	0-10	Loam	CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	20-30	5-15
	10-19	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	60-75	30-45	<30	3-15
	19-37	Sandy loam, loamy sand.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	50-70	15-40	<30	3-15
	37-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-4, A-2, A-6	0	100	100	50-70	15-40	<30	3-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
36E, 36E--------- Maddock	0-8	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	8-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
37--------------- Arveson	0-8	Loam-------------	ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
	8-43	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	43-60	Loamy sand, loamy fine sand.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5
38--------------- Hegne	0-11	Silty clay-------	CH	A-7	0	100	100	95-100	90-98	50-70	25-40
	11-19	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	25-40
	19-36	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
	36-60	Clay, silty clay	CH	A-7	0	100	100	95-100	95-100	50-70	25-45
39--------------- Hegne	0-11	Silty clay-------	OH, CH	A-7	0	100	100	95-100	90-98	50-70	11-30
	11-36	Silty clay, clay	CH	A-7	0	100	100	95-100	95-98	50-70	22-40
	36-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	50-75	22-45
40--------------- Glyndon	0-8	Silt loam--------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	8-28	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	28-60	Loamy very fine sand, very fine sand, very fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0	100	100	85-100	35-75	10-35	NP-15
41--------------- Kelvin	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-15
	7-28	Clay loam, clay	CL, CH	A-7, A-6	0-5	95-100	90-100	90-100	70-90	35-60	20-35
	28-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	90-100	75-100	50-80	30-50	10-30
42*:											
Suomi-----------	0-6	Silty clay loam	CL, CH	A-6, A-7	0-5	95-100	90-100	90-100	85-100	30-55	10-30
	6-9	Silt loam, loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	90-100	75-100	25-45	5-25
	9-25	Clay, silty clay, silty clay loam.	CH	A-7	0-5	95-100	90-100	90-100	70-90	50-75	25-50
	25-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-5	95-100	90-100	85-100	60-85	25-50	5-25
Kelvin----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-95	60-75	20-40	5-15
	7-28	Clay loam, clay	CL, CH	A-7, A-6	0-5	95-100	90-100	90-100	70-90	35-60	20-35
	28-60	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	90-100	75-100	50-80	30-50	10-30
44, 44B, 44C----- Waukon	0-9	Loam-------------	OL, ML, CL, CL-ML	A-6, A-7, A-4	0-3	95-100	90-100	80-95	60-90	20-50	3-30
	9-40	Clay loam, loam, sandy clay loam.	CL	A-6, A-7	0-3	95-100	90-100	75-95	50-85	20-50	10-30
	40-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	90-100	70-95	50-80	15-45	5-20
46F*:											
Olga------------	0-12	Silty clay loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	75-95	35-70	20-45
	12-60	Silty clay, clay, clay loam.	CH, CL, MH	A-7, A-6	0-1	95-100	80-100	65-100	50-95	35-70	20-45

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
46F*:											
Kloten	0-4	Loam	CL, CL-ML	A-4, A-6	0-10	90-100	90-100	85-95	60-90	20-40	5-20
	4-16	Extremely channery loam, channery loam, loam.	CL-ML, CL	A-4, A-6	0-10	90-100	80-100	70-95	60-90	20-40	5-20
	16-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
48 Cashel	0-7	Silty clay	CH, CL	A-7	0	100	100	95-100	85-100	45-70	20-40
	7-60	Silty clay, clay, silty clay loam.	CH, CL, MH	A-7	0	95-100	95-100	95-100	85-100	45-70	20-40
49C*:											
Fordville	0-7	Loam	ML, CL	A-4, A-6, A-7	0	100	100	70-85	55-75	30-45	5-20
	7-17	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	70-95	55-80	30-45	5-20
	17-27	Loam, clay loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0	95-100	90-100	65-90	40-55	25-40	3-15
	27-60	Gravelly loamy sand, gravelly sand, loamy sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-45	0-15	<25	NP-5
49C*:											
Sioux	0-7	Gravelly loam	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	7-10	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	10-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
51 Colvin	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	8-23	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	23-60	Clay loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
53 Hamar	0-11	Loamy fine sand	SM, SM-SC	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	11-19	Loamy fine sand, loamy sand.	SM, SM-SC	A-2, A-4	0	100	100	85-100	15-40	<25	NP-5
	19-60	Fine sand, sand, loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	100	70-100	10-35	<25	NP-5
55 Roliss	0-19	Silt loam	CL, CL-ML	A-4, A-6	0	95-100	80-100	80-100	60-90	20-40	5-20
	19-33	Clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	80-100	80-90	60-80	20-50	10-30
	33-60	Loam, clay loam	CL, CL-ML	A-6, A-7, A-4	0	95-100	80-98	80-95	60-80	20-50	5-30
57*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
1----------------- Southam	0-27	0.06-0.2	0.15-0.18	6.6-8.4	2-8	High------	0.28	5	4
	27-44	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High------	0.28		
	44-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High------	0.28		
2*:									
Vallers---------	0-11	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low-------	0.28	5	4L
	11-23	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low-------	0.28		
	23-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
Parnell---------	0-24	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	24-43	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	43-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
3----------------- Parnell	0-24	0.6-2.0	0.22-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	24-43	0.06-0.2	0.13-0.19	6.1-7.8	<2	High------	0.28		
	43-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High------	0.28		
4----------------- Easby	0-7	0.6-2.0	0.03-0.05	7.4-9.0	>16	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.07-0.10	7.4-9.0	>8	Moderate	0.28		
5*:									
Manfred---------	0-7	0.06-0.2	0.17-0.23	7.9-9.0	2-4	High------	0.32	3	7
	7-60	0.06-0.2	0.17-0.23	7.9-9.0	2-16	High------	0.32		
Vallers---------	0-11	0.2-0.6	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	11-23	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low-------	0.28		
	23-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low-------	0.28		
6----------------- La Prairie	0-18	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	6
	18-25	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28		
	25-46	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
	46-60	0.6-2.0	0.15-0.22	6.6-8.4	<2	Moderate	0.28		
7----------------- Fairdale	0-8	0.6-2.0	0.20-0.24	7.4-7.8	<2	Low-------	0.32	5	6
	8-60	0.6-2.0	0.17-0.23	7.4-8.4	<2	Moderate	0.32		
8----------------- Lamoure	0-16	0.6-2.0	0.19-0.22	7.4-8.4	<4	Moderate	0.28	5	4L
	16-38	0.6-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.28		
	38-60	0.6-2.0	0.09-0.18	7.4-8.4	<4	Low-------	0.28		
10*, 10B*:									
Svea------------	0-14	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	14-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-8	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	8-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
11B*, 11C*:									
Svea------------	0-14	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	14-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse------------	0-9	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low-------	0.28	5	4L
	9-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
11D*, 11E*:									
Buse------------	0-9	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L
	9-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-14	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	14-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
12B*:									
Barnes----------	0-8	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	8-15	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	15-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse------------	0-9	0.2-0.6	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L
	9-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
14--------------- Divide	0-12	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28	4	4L
	12-24	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.28		
	24-60	>20	0.03-0.07	7.4-8.4	<2	Low--------	0.10		
15*:									
Wyard-----------	0-21	0.6-2.0	0.20-0.24	6.6-7.8	<2	Moderate	0.28	5	6
	21-60	0.6-2.0	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
Hamerly---------	0-8	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	8-17	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
16*:									
Hamerly---------	0-8	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	8-17	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka-----------	0-13	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low--------	0.32	5	6
	13-31	0.06-0.2	0.14-0.19	5.6-7.8	<2	High-------	0.43		
	31-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
17*:									
Vallers---------	0-11	0.6-2.0	0.14-0.16	7.4-8.4	4-16	Low--------	0.28	5	4L
	11-23	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Low--------	0.28		
	23-60	0.2-0.6	0.11-0.13	7.4-8.4	4-16	Low--------	0.28		
Hamerly---------	0-8	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	8-17	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	17-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
19*:									
Hamerly---------	0-8	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	8-17	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	17-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Cresbard--------	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	8-18	0.06-0.2	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	18-37	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High-------	0.32		
	37-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
20*, 20B*:									
Cresbard--------	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	8-18	0.06-0.2	0.11-0.14	5.6-7.3	2-4	High-------	0.32		
	18-37	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High-------	0.32		
	37-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
20*, 20B*:									
Svea------------	0-14	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.28	5	6
	14-21	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	21-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
21*:									
Cavour----------	0-9	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	9-25	<0.06	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	25-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Cresbard--------	0-8	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low--------	0.32	3	6
	8-18	0.06-0.2	0.11-0.14	5.6-7.3	2-4	High------	0.32		
	18-37	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	37-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
22*:									
Miranda---------	0-8	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.32	3	6
	8-15	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	15-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
Cavour----------	0-9	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	9-25	<0.06	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	25-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
23B-------------- Mekinock	0-2	0.6-2.0	0.18-0.22	5.6-7.8	<2	Moderate	0.24	3	6
	2-25	<0.06	0.10-0.15	6.1-9.0	4-16	High------	0.32		
	25-60	---	---	---	---	----------	----		
25--------------- Hattie	0-7	0.06-0.2	0.16-0.22	7.4-8.4	<2	High------	0.28	5	4
	7-60	0.06-0.2	0.12-0.16	7.4-8.4	<2	High------	0.28		
26, 26B, 26C----- Rolette	0-8	0.6-2.0	0.17-0.23	6.1-7.3	<2	High------	0.32	5	4
	8-60	0.2-0.6	0.13-0.20	6.6-8.4	<2	High------	0.32		
27D, 27E--------- Olga	0-12	0.06-0.2	0.16-0.23	5.6-7.3	<2	High------	0.43	5	6
	12-50	0.06-0.2	0.13-0.16	4.5-7.8	<2	High------	0.32		
	50-60	---	---	---	---	----------	----		
30F*:									
Kloten----------	0-7	0.6-2.0	0.17-0.22	6.1-7.8	<2	Moderate	0.32	2	6
	7-14	0.6-2.0	0.05-0.19	6.1-7.8	<2	Moderate	0.10		
	14-60	---	---	---	---	----------	----		
Walsh-----------	0-11	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.28	5	6
	11-60	0.6-2.0	0.14-0.22	6.1-7.8	<2	Moderate	0.43		
Edgeley---------	0-9	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.28	4	6
	9-27	0.6-2.0	0.13-0.19	6.1-7.8	<2	Moderate	0.28		
	27-60	---	---	---	---	----------	----		
31C-------------- Binford	0-7	2.0-6.0	0.13-0.15	5.6-7.8	<2	Low--------	0.20	3	3
	7-14	2.0-6.0	0.12-0.18	5.6-8.4	<2	Low--------	0.20		
	14-60	6.0-20	0.02-0.08	5.6-8.4	<2	Low--------	0.10		
32--------------- Brantford	0-15	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low--------	0.28	3	6
	15-60	>20	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
33--------------- Vang	0-11	0.6-2.0	0.17-0.21	6.1-7.3	<2	Low--------	0.28	4	6
	11-27	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low--------	0.28		
	27-60	>20	0.02-0.04	6.1-8.4	<2	Low--------	0.10		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
33B*, 33C*:									
Vang------------	0-11	0.6-2.0	0.17-0.21	6.1-7.3	<2	Low-------	0.28	4	6
	11-27	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low-------	0.28		
	27-60	>20	0.02-0.04	6.1-8.4	<2	Low-------	0.10		
Coe-------------	0-7	0.6-6.0	0.10-0.18	6.6-7.8	<2	Low-------	0.15	2	8
	7-60	>20	0.02-0.05	7.4-8.4	<2	Low-------	0.15		
34*:									
Walsh-----------	0-9	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.28	5	6
	9-60	0.6-2.0	0.14-0.22	6.1-7.8	<2	Moderate	0.43		
Vang------------	0-9	0.6-2.0	0.17-0.21	6.1-7.3	<2	Low-------	0.28	4	6
	9-37	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low-------	0.28		
	37-60	>6.0	0.02-0.04	6.1-8.4	<2	Low-------	0.10		
34B*:									
Walsh-----------	0-9	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.28	5	6
	9-41	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28		
	41-60	>20	0.02-0.04	6.1-8.4	<2	Low-------	0.10		
Vang------------	0-12	0.6-2.0	0.17-0.21	6.1-7.3	<2	Low-------	0.28	4	6
	12-35	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low-------	0.28		
	35-60	>6.0	0.02-0.04	6.1-8.4	<2	Low-------	0.10		
35--------------- Inkster	0-10	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low-------	0.28	5	5
	10-19	2.0-6.0	0.12-0.14	5.6-7.3	<2	Low-------	0.20		
	19-37	2.0-6.0	0.08-0.13	5.6-7.8	<2	Low-------	0.20		
	37-60	2.0-6.0	0.08-0.13	5.6-7.8	<2	Low-------	0.20		
36B, 36E--------- Maddock	0-8	6.0-20	0.08-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	8-60	6.0-20	0.05-0.13	6.1-8.4	<2	Low-------	0.17		
37--------------- Arveson	0-8	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.24	4	4L
	8-43	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24		
	43-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low-------	0.17		
38--------------- Hegne	0-11	0.06-0.2	0.14-0.17	7.4-8.4	<2	High------	0.32	5	4
	11-19	0.06-0.2	0.13-0.16	7.4-8.4	<4	High------	0.32		
	19-36	0.06-0.2	0.09-0.16	7.4-8.4	<4	High------	0.32		
	36-60	<0.06	0.08-0.14	7.4-8.4	<4	High------	0.32		
39--------------- Hegne	0-11	0.06-0.2	0.10-0.15	7.4-9.0	4-16	High------	0.28	5	4
	11-36	0.06-0.2	0.09-0.14	7.4-9.0	4-16	High------	0.28		
	36-60	<0.06	0.07-0.12	7.4-9.0	4-16	High------	0.28		
40--------------- Glyndon	0-8	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	5	4L
	8-28	2.0-6.0	0.17-0.20	7.4-9.0	<4	Low-------	0.28		
	28-60	2.0-6.0	0.15-0.19	7.4-9.0	<4	Low-------	0.28		
41--------------- Kelvin	0-7	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low-------	0.28	5	6
	7-28	0.2-0.6	0.14-0.19	4.5-7.8	<2	Moderate	0.37		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
42*:									
Suomi-----------	0-6	0.2-0.6	0.18-0.23	5.6-7.3	<2	Moderate	0.28	5	7
	6-9	0.6-2.0	0.20-0.24	5.6-7.3	<2	Moderate	0.28		
	9-25	0.06-0.2	0.13-0.16	5.6-7.8	<2	High------	0.28		
	25-60	0.2-0.6	0.15-0.20	7.4-8.4	<2	Moderate	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
42*:									
Kelvin----------	0-7	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6
	7-28	0.2-0.6	0.14-0.19	4.5-7.8	<2	Moderate	0.37		
	28-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
44, 44B, 44C----- Waukon	0-9	0.6-2.0	0.20-0.24	6.1-7.3	<2	Moderate	0.24	5	6
	9-40	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.32		
	40-60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low--------	0.32		
46F*:									
Olga------------	0-12	0.06-0.2	0.16-0.23	5.6-7.3	<2	High------	0.43	3	4
	12-60	0.06-0.2	0.13-0.16	4.5-7.8	<2	High------	0.32		
Kloten----------	0-4	0.6-2.0	0.17-0.22	6.1-7.8	<2	Moderate	0.32	2	6
	4-16	0.6-2.0	0.05-0.19	6.1-7.8	<2	Moderate	0.10		
	16-60	---	---	---	---	----------	----		
48--------------- Cashel	0-7	0.06-0.6	0.15-0.18	7.4-8.4	<2	High------	0.32	5	4
	7-60	0.06-0.2	0.13-0.17	7.4-8.4	<2	High------	0.32		
49C*:									
Fordville-------	0-7	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.24	4	6
	7-17	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.24		
	17-27	0.6-6.0	0.12-0.18	6.1-7.8	<2	Low--------	0.24		
	27-60	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
Sioux-----------	0-7	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low--------	0.20	2	8
	7-10	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20		
	10-60	>20	0.03-0.06	7.4-8.4	<2	Low--------	0.10		
51--------------- Colvin	0-8	0.2-0.6	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	8-23	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	23-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
53--------------- Hamar	0-11	6.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2
	11-19	6.0-20	0.10-0.12	6.6-8.4	<2	Low--------	0.17		
	19-60	6.0-20	0.06-0.08	7.4-8.4	<2	Low--------	0.17		
55--------------- Roliss	0-19	0.2-2.0	0.17-0.24	6.6-8.4	<2	Moderate	0.28	5	6
	19-33	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	33-60	0.2-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
57*. Pits									

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "occasional," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
1----------------- Southam	D	None---------	---	---	+5-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
2*:												
Vallers-----------	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
Parnell-----------	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
3----------------- Parnell	C/D	None---------	---	---	+2-2.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
4----------------- Easby	D	None---------	---	---	0-1.0	Apparent	Sep-Jun	>60	---	High-----	High-----	High.
5*:												
Manfred-----------	D	None---------	---	---	+1-1.0	Apparent	Mar-Aug	>60	---	High-----	High-----	Low.
Vallers-----------	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
6----------------- La Prairie	B	Occasional	Brief-----	Mar-Jun	3.5-6.0	Apparent	Mar-Jun	>60	---	Moderate	Moderate	Low.
7----------------- Fairdale	B	Occasional	Brief-----	Mar-Jun	>6.0	---	---	>60	---	Moderate	Moderate	Low.
8----------------- Lamoure	C	Occasional	Brief-----	Mar-Oct	0-2.0	Apparent	Oct-Jun	>60	---	High-----	High-----	Moderate.
10*, 10B*:												
Svea--------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
Barnes------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
11B*:												
Svea--------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
Buse--------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
11C*:												
Svea--------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Buse--------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
11D*, 11E*:												
Buse-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Svea-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
12B*:												
Barnes-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Buse-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
14--------------- Divide	B	None---------	---	---	2.5-5.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
15*:												
Wyard------------	B	None---------	---	---	1.0-3.0	Apparent	Mar-Jun	>60	---	High-----	High-----	Low.
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
16*:												
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
Tonka------------	C/D	None---------	---	---	+.5-1.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
17*:												
Vallers----------	C	None---------	---	---	0-1.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Moderate.
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Moderate.
19*:												
Hamerly----------	C	None---------	---	---	2.0-4.0	Apparent	Apr-Jun	>60	---	High-----	High-----	Low.
Cresbard---------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
20*, 20B*:												
Cresbard---------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
Svea-------------	B	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Low.
21*:												
Cavour-----------	D	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
Cresbard---------	C	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.
22*:												
Miranda----------	D	None---------	---	---	2.0-4.0	Apparent	Apr-Jul	>60	---	Moderate	High-----	Moderate.
Cavour-----------	D	None---------	---	---	4.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	High-----	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
23B--------------- Mekinock	D	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High------	Moderate.
25---------------- Hattie	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
26, 26B, 26C------ Rolette	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
27D, 27E---------- Olga	C	None---------	---	---	>6.0	---	---	40-60	Soft	Moderate	High------	Moderate.
30F*:												
Kloten------------	D	None---------	---	---	>6.0	---	---	9-20	Soft	Moderate	High------	Low.
Walsh-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
Edgeley-----------	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High------	Low.
31C--------------- Binford	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate	Low.
32---------------- Brantford	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate	Low.
33---------------- Vang	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
33B*, 33C*:												
Vang--------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
Coe---------------	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate	Low.
34*, 34B*:												
Walsh-------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
Vang--------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
35---------------- Inkster	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
36B, 36E---------- Maddock	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate	Low.
37---------------- Arveson	B/D	None---------	---	---	1.0-2.0	Apparent	Apr-Jul	>60	---	High------	High------	Low.
38---------------- Hegne	D	None---------	---	---	1.0-2.5	Apparent	Apr-Jul	>60	---	Moderate	High------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
39----------------- Hegne	D	None---------	---	---	+1-2.5	Apparent	Jan-Dec	>60	---	Moderate	High-----	Low.
40----------------- Glyndon	B	None---------	---	---	2.5-6.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Low.
41----------------- Kelvin	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
42*:												
Suomi------------	C	None---------	---	---	2.5-5.0	Apparent	May-Jul	>60	---	High-----	High-----	Low.
Kelvin-----------	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
44, 44B, 44C------ Waukon	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
46F*:												
Olga-------------	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Kloten-----------	D	None---------	---	---	>6.0	---	---	9-20	Soft	Moderate	High-----	Low.
48----------------- Cashel	C	Occasional	Brief-----	Mar-May	1.0-3.0	Apparent	Apr-Jul	>60	---	Moderate	High-----	Low.
49C*:												
Fordville---------	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Low.
Sioux------------	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
51----------------- Colvin	C/D	None---------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
53----------------- Hamar	A/D	None---------	---	---	0.5-2.0	Apparent	Oct-Jun	>60	---	Moderate	High-----	Low.
55----------------- Roliss	B/D	None---------	---	---	+.5-3.0	Apparent	Apr-Jul	>60	---	High-----	High-----	Low.
57*. Pits												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Barnes loam: (S80ND-019-051)														
Bw------ 8 to 15	A-6(10)	CL	100	100	98	89	68	---	24	---	36	18	120	12
C------- 26 to 60	A-6(8)	CL	96	93	88	77	56	---	24	---	37	19	120	12
Brantford loam: (S80ND-019-009)														
Bw------ 7 to 15	A-7-6(13)	ML	100	99	96	81	68	---	26	---	48	19	101	20
2C2----- 19 to 45	A-1-b(0)	SP-SM	90	82	53	19	11	---	2	---	---	NP	106	17
Buse loam: (S83ND-019-200)														
Bk1----- 7 to 21	A-6(6)	CL	100	99	92	78	56	---	19	---	34	14	118	13
Cy------ 48 to 60	A-7-6(7)	ML	100	99	92	80	64	---	31	---	41	13	---	---
Cavour loam: (S83ND-019-205)														
Bt------ 7 to 17	A-7-5(19)	MH	100	100	99	89	71	---	34	---	61	27	---	---
C1------ 42 to 53	A-7-6(6)	ML	100	99	90	74	53	---	17	---	44	16	---	---
Cresbard loam: (S83ND-019-204)														
Bt------ 11 to 18	A-7-5(14)	MH	100	100	99	89	75	---	36	---	51	20	---	---
C1------ 35 to 52	A-4(4)	CL	100	99	91	78	53	---	17	---	27	8	---	---
Divide loam: (S82ND-019-169)														
Bk------ 12 to 24	A-7-6(2)	CL	96	87	76	55	36	---	13	---	44	19	118	13
2C------ 24 to 60	A-1-b(0)	SP-SM	90	81	65	33	11	---	4	---	25	5	114	14
Easby clay loam: (S83ND-019-250)														
Bky----- 11 to 22	A-7-5(15)	MH	100	98	93	82	65	---	39	---	54	24	101	20
C1------ 30 to 43	A-7-6(10)	CL	98	96	93	80	59	---	28	---	47	20	105	18

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TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Edgeley loam: (S80ND-019-045)														
Bw------ 9 to 20	A-7-5(13)	MH	100	98	96	82	64	---	33	---	59	20	85	28
C------- 20 to 27	A-7-5(15)	MH	100	100	100	80	67	---	34	---	64	19	79	29
Hamerly loam: (S83ND-019-201)														
Bk1----- 16 to 25	A-6(8)	CL	100	99	94	84	65	---	29	---	37	15	110	16
C2------ 50 to 60	A-6(5)	CL	100	99	92	80	58	---	21	---	32	11	118	13
Hattie clay: (S84ND-019-306)														
Bw------ 7 to 16	A-7-6(20)	CH	100	100	100	97	92	---	66	---	66	37	104	19
Cy------ 37 to 60	A-7-6(20)	CH	100	100	100	98	94	---	70	---	72	44	106	18
Kelvin loam: (S83ND-019-207)														
Bt1----- 10 to 21	A-7-6(14)	CL	100	100	99	90	71	---	39	---	51	23	---	---
C1------ 41 to 60	A-6(4)	ML	100	99	93	78	54	---	18	---	37	10	105	18
Mekinock loam: (S83ND-019-229)														
Bt------ 2 to 11	A-7-5(38)	CH	100	100	100	97	92	---	51	---	66	35	100	20
2Cn----- 25 to 60	A-7-6(70)	CH	99	98	97	96	96	---	75	---	90	63	107	17
Olga silty clay loam: (S84ND-019-305)														
Bt1----- 17 to 23	A-7-5(20)	MH	100	100	100	91	81	---	50	---	68	32	89	26
C1------ 29 to 52	A-7-5(12)	MH	100	95	84	66	54	---	30	---	60	25	88	25
Rolette clay loam: (S82ND-019-180)														
Bt1----- 12 to 21	A-7-5(29)	CH	100	100	100	97	91	---	58	---	57	27	104	18
C------- 49 to 60	A-7-6(16)	CH	100	99	98	82	71	---	43	---	50	22	103	19
Svea loam: (S83ND-019-202)														
Bw------ 14 to 21	A-6(6)	CL	100	100	100	88	61	---	16	---	36	13	114	14
C1------ 42 to 53	A-4(6)	ML	100	100	98	85	66	---	24	---	33	9	---	---

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft3	Pct
Tonka loam: (S83ND-019-203)														
Bt1----- 22 to 29	A-7-6(11)	CL	100	100	100	99	93	---	44	---	48	21	---	---
C------- 42 to 55	A-6(4)	CL	100	98	87	61	50	---	16	---	34	13	113	15
Walsh loam: (S83ND-019-209)														
Bw1----- 15 to 24	A-7-5(12)	MH	100	100	100	84	67	---	28	---	59	18	---	---
C------- 48 to 60	A-7-5(12)	ML	100	100	99	89	75	---	22	---	49	14	---	---
Waukon loam: (S83ND-019-206)														
C1------ 40 to 51	A-7-6(4)	ML	100	98	92	76	57	---	17	---	40	11	---	---

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Binford	Sandy, mixed Udic Haploborolls
Brantford	Fine-loamy over sandy or sandy-skeletal, mixed Udic Haploborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cashel	Fine, montmorillonitic (calcareous), frigid Aquic Udifluvents
Cavour	Fine, montmorillonitic Udic Natriborolls
Coe	Sandy-skeletal, mixed Udorthentic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
*Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Easby	Fine-loamy, frigid Typic Calciaquolls
*Edgeley	Fine-loamy, mixed Udic Haploborolls
*Fairdale	Fine-loamy, mixed (calcareous), frigid Mollic Udifluvents
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Hamar	Sandy, mixed, frigid Typic Haplaquolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Hattie	Fine, montmorillonitic Udertic Haploborolls
Hegne	Fine, frigid Typic Calciaquolls
Inkster	Coarse-loamy, mixed Pachic Udic Haploborolls
Kelvin	Fine, montmorillonitic Typic Eutroboralfs
Kloten	Loamy, mixed Lithic Haploborolls
La Prairie	Fine-loamy, mixed Cumulic Udic Haploborolls
Lamoure	Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Manfred	Fine-loamy, mixed, frigid Typic Natraquolls
Mekinock	Fine, montmorillonitic Leptic Natriborolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Olga	Fine, montmorillonitic Boralfic Udic Argiborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Rolette	Fine, montmorillonitic Boralfic Udic Argiborolls
Roliss	Fine-loamy, mixed (calcareous), frigid Typic Haplaquolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Suomi	Fine, mixed Aquic Eutroboralfs
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Vallers	Fine-loamy, frigid Typic Calciaquolls
Vang	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Walsh	Fine-loamy, mixed Pachic Udic Haploborolls
Waukon	Fine-loamy, mixed Mollic Eutroboralfs
Wyard	Fine-loamy, mixed, frigid Typic Haplaquolls

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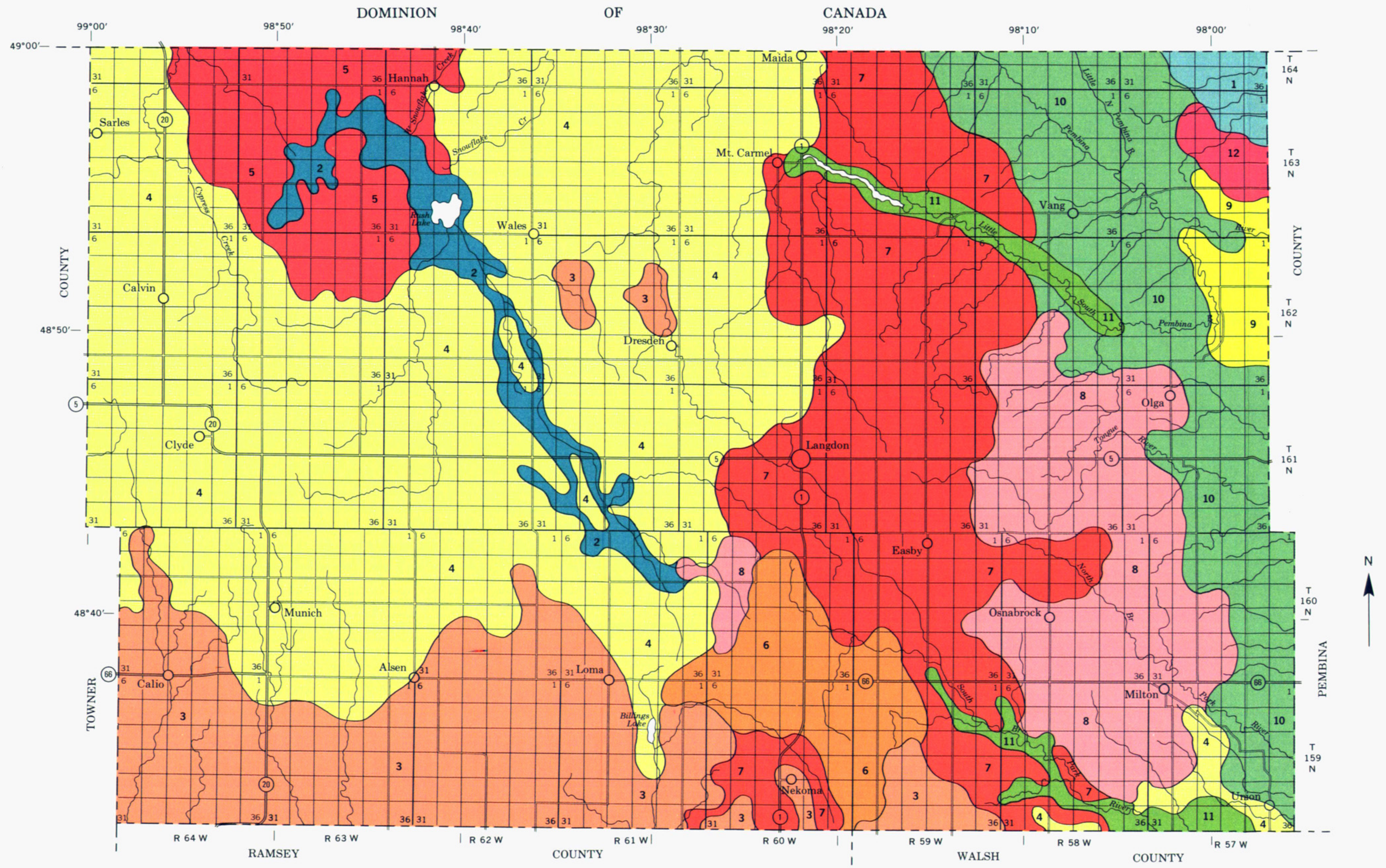
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



LEGEND*

LEVEL AND NEARLY LEVEL, CLAYEY, SILTY, AND LOAMY SOILS

1 HEGNE-GLYNDON association: Deep, level, poorly drained and somewhat poorly drained, fine textured and medium textured soils

2 VALLERS-SOUTHAM-HAMERLY association: Deep, level and nearly level, very poorly drained to somewhat poorly drained, medium textured, moderately fine textured, and fine textured soils

LEVEL TO ROLLING, LOAMY AND SILTY SOILS

3 SVEA-HAMERLY-BUSE association: Deep, level to rolling, well drained to somewhat poorly drained, medium textured soils

4 HAMERLY-SVEA-TONKA association: Deep, level and nearly level, moderately well drained to poorly drained, medium textured soils

5 HAMERLY-WALSH-PARNELL association: Deep, level to undulating, somewhat poorly drained, well drained, and very poorly drained, medium textured soils

6 SVEA-HAMERLY-TONKA association: Deep, level to undulating, moderately well drained to poorly drained, medium textured soils

7 SVEA-HAMERLY-CRESBARD association: Deep, level to undulating, moderately well drained and somewhat poorly drained, medium textured soils

8 CRESBARD-CAVOUR-SVEA association: Deep, level to undulating, moderately well drained, medium textured, dominantly alkali soils

9 VANG-BRANTFORD-WALSH association: Deep, level to gently rolling, well drained, medium textured soils

LEVEL TO VERY STEEP, SILTY AND LOAMY SOILS

10 OLGA-WAUKON-ROLETTE association: Deep, level to steep, well drained and moderately well drained, moderately fine textured and medium textured soils

11 KLOTEN-BUSE-WALSH association: Shallow and deep, moderately sloping to very steep, well drained, medium textured soils

LEVEL TO STEEP, SANDY AND LOAMY SOILS

12 MADDOCK-ARVESON-BINFORD association: Deep, level to steep, well drained, poorly drained, and somewhat excessively drained, coarse textured, medium textured, and moderately coarse textured soils

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

COMPILED 1988

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

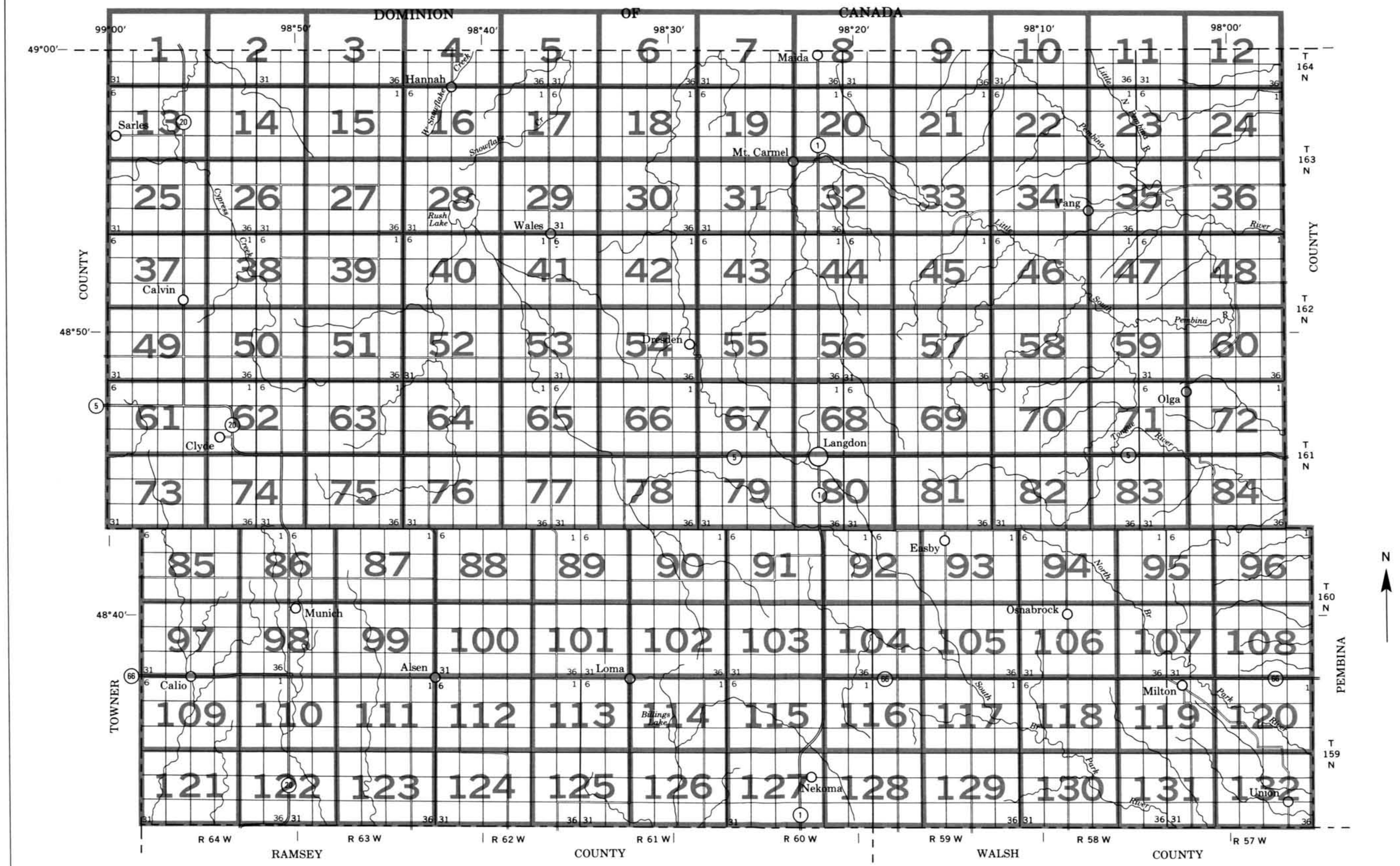
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

GENERAL SOIL MAP
CAVALIER COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km



Original text from each individual map sheet read:
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

CAVALIER COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km

SOIL LEGEND

Map symbols consist of a number or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils.

SYMBOL	NAME
1	Southam clay
2	Vallers, saline-Parnell complex
3	Parnell silt loam
4	Easby clay loam
5	Manfred-Vallers, saline, silty clay loams
6	La Prairie loam
7	Fairdale loam, channeled
8	Lamoure silt loam
10	Svea-Barnes loams, 0 to 3 percent slopes
10B	Svea-Barnes loams, 3 to 6 percent slopes
11B	Svea-Buse loams, 3 to 6 percent slopes
11C	Svea-Buse loams, 6 to 9 percent slopes
11D	Buse-Svea loams, 9 to 15 percent slopes
11E	Buse-Svea loams, 15 to 35 precent slopes
12B	Barnes-Buse loams, 3 to 6 percent slopes
14	Divide loam, 1 to 3 percent slopes
15	Wyard-Hamerly loams, 0 to 3 percent slopes
16	Hamerly-Tonka loams, 0 to 3 percent slopes
17	Vallers-Hamerly loams, saline, 0 to 3 percent slopes
19	Hamerly-Cresbard loams, 1 to 3 percent slopes
20	Cresbard-Svea loams, 1 to 3 percent slopes
20B	Cresbard-Svea loams, 3 to 6 percent slopes
21	Cavour-Cresbard loams, 0 to 3 percent slopes
22	Miranda-Cavour loams
23B	Mekinock loam, 0 to 6 percent slopes
25	Hattie clay, 1 to 3 percent slopes
26	Rolette clay loam, 1 to 3 percent slopes
26B	Rolette clay loam, 3 to 6 percent slopes
26C	Rolette silty clay loam, 6 to 9 percent slopes
27D	Olga silty clay loam, 9 to 15 percent slopes
27E	Olga silty clay loam, 15 to 35 percent slopes
30F	Kloten-Walsh-Edgeley loams, 6 to 35 precent slopes
31C	Binford sandy loam, 1 to 9 percent slopes
32	Brantford loam, 0 to 3 percent slopes
33	Vang loam, 0 to 3 percent slopes
33B	Vang-Coe complex, 3 to 6 percent slopes
33C	Vang-Coe complex, 6 to 9 percent slopes
34	Walsh-Vang loams, 0 to 3 percent slopes
34B	Walsh, sand substratum-Vang loams, 3 to 6 percent slopes
35	Inkster loam, 0 to 3 percent slopes
36B	Maddock loamy fine sand, 1 to 6 percent slopes
36E	Maddock loamy fine sand, 9 to 35 percent slopes
37	Arveson loam
38	Hegne silty clay
39	Hegne silty clay, saline
40	Glyndon silt loam
41	Kelvin loam, 0 to 3 percent slopes
42	Suomi-Kelvin complex, 0 to 3 percent slopes
44	Waukon loam, 0 to 3 percent slopes
44B	Waukon loam, 3 to 6 percent slopes
44C	Waukon loam, 6 to 9 percent slopes
46F	Olga-Kloten complex, 9 to 120 percent slopes
48	Cashel silty clay
49C	Fordville-Sioux complex, 3 to 9 percent slopes
51	Colvin silty clay loam
53	Hamar loamy fine sand
55	Roliss silt loam
57	Pits

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Swift Airport

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small — water, w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 32, 11C

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

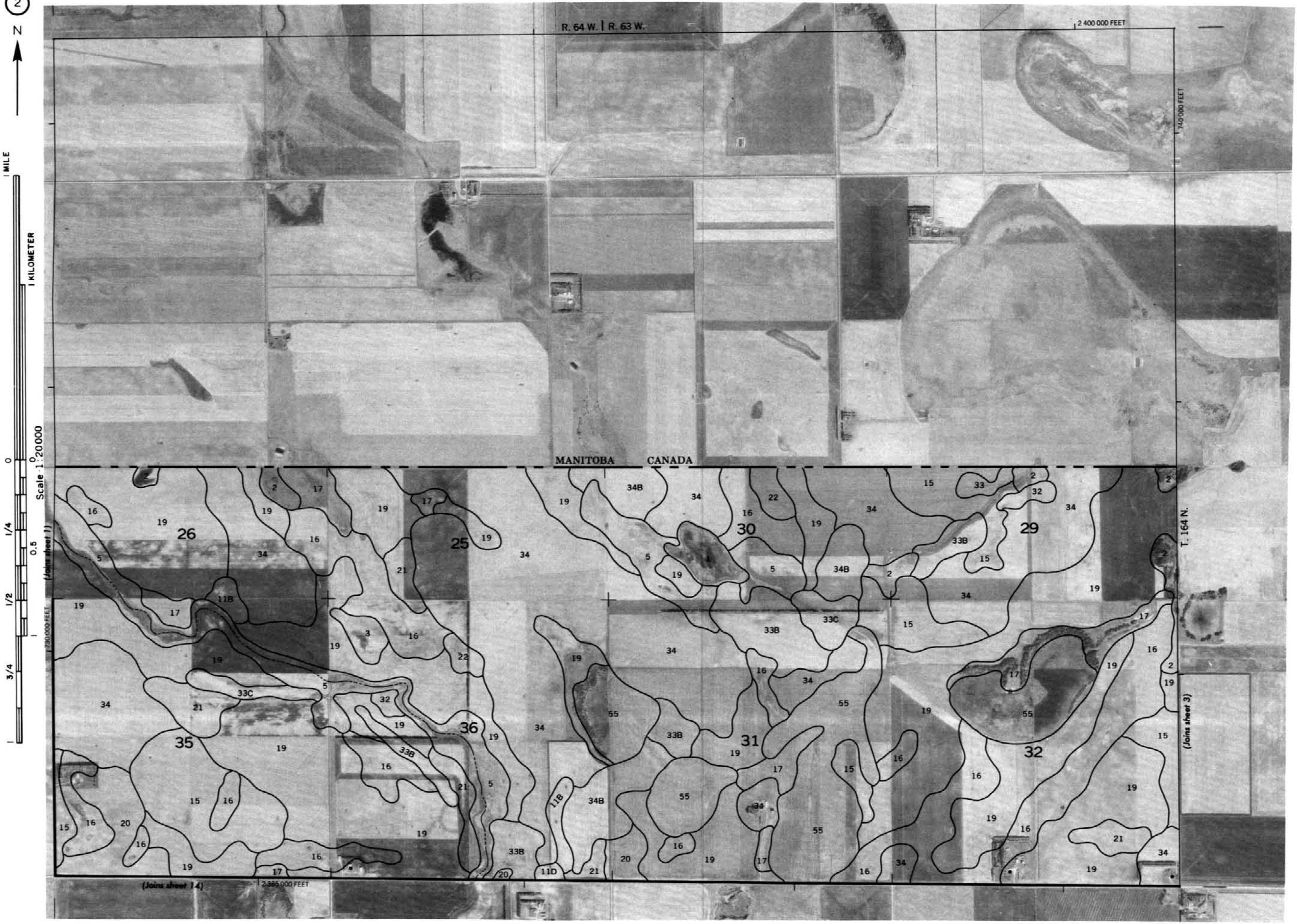
SOIL SAMPLE (normally not shown) — S

MISCELLANEOUS

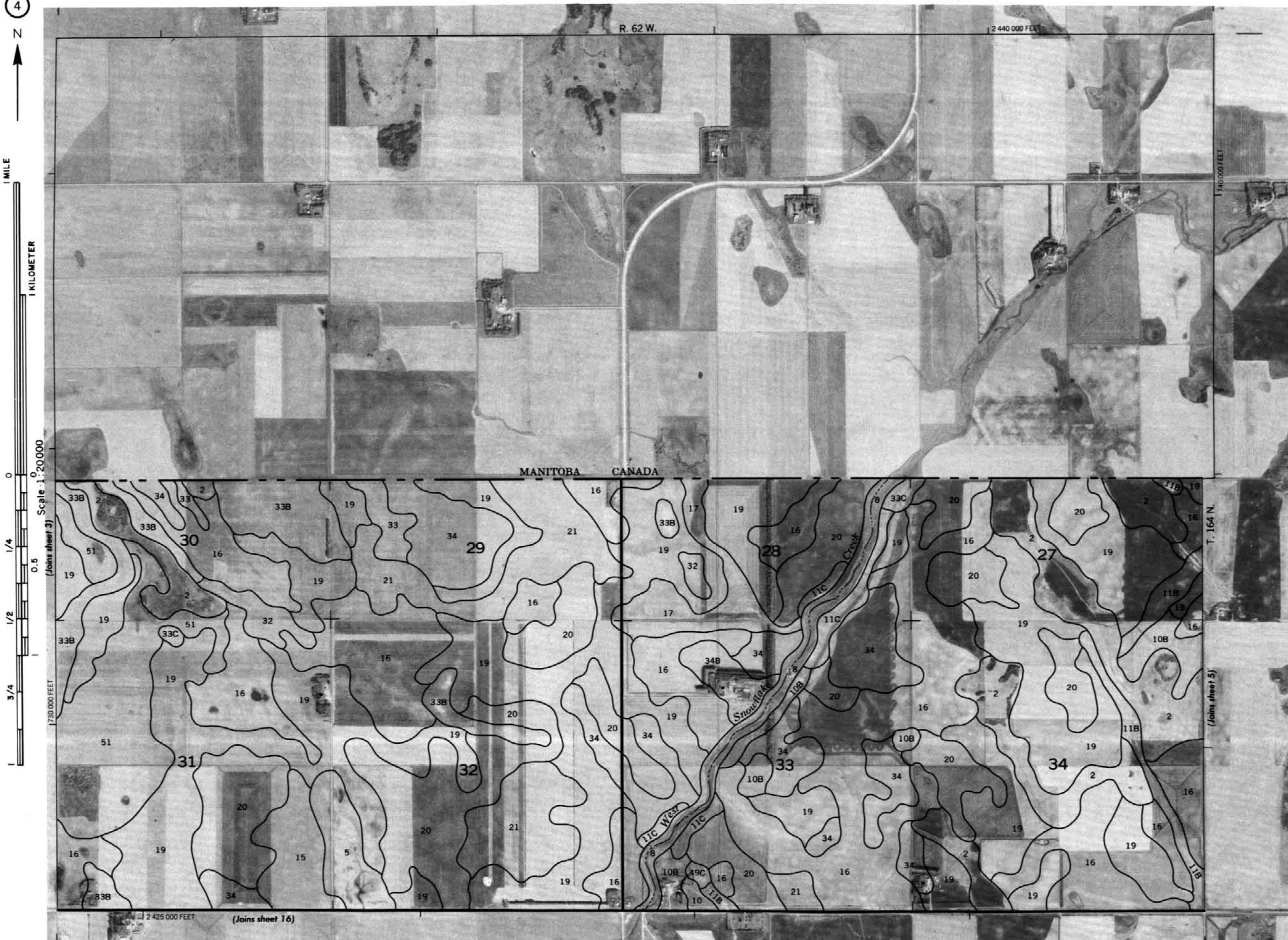
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 1

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 2



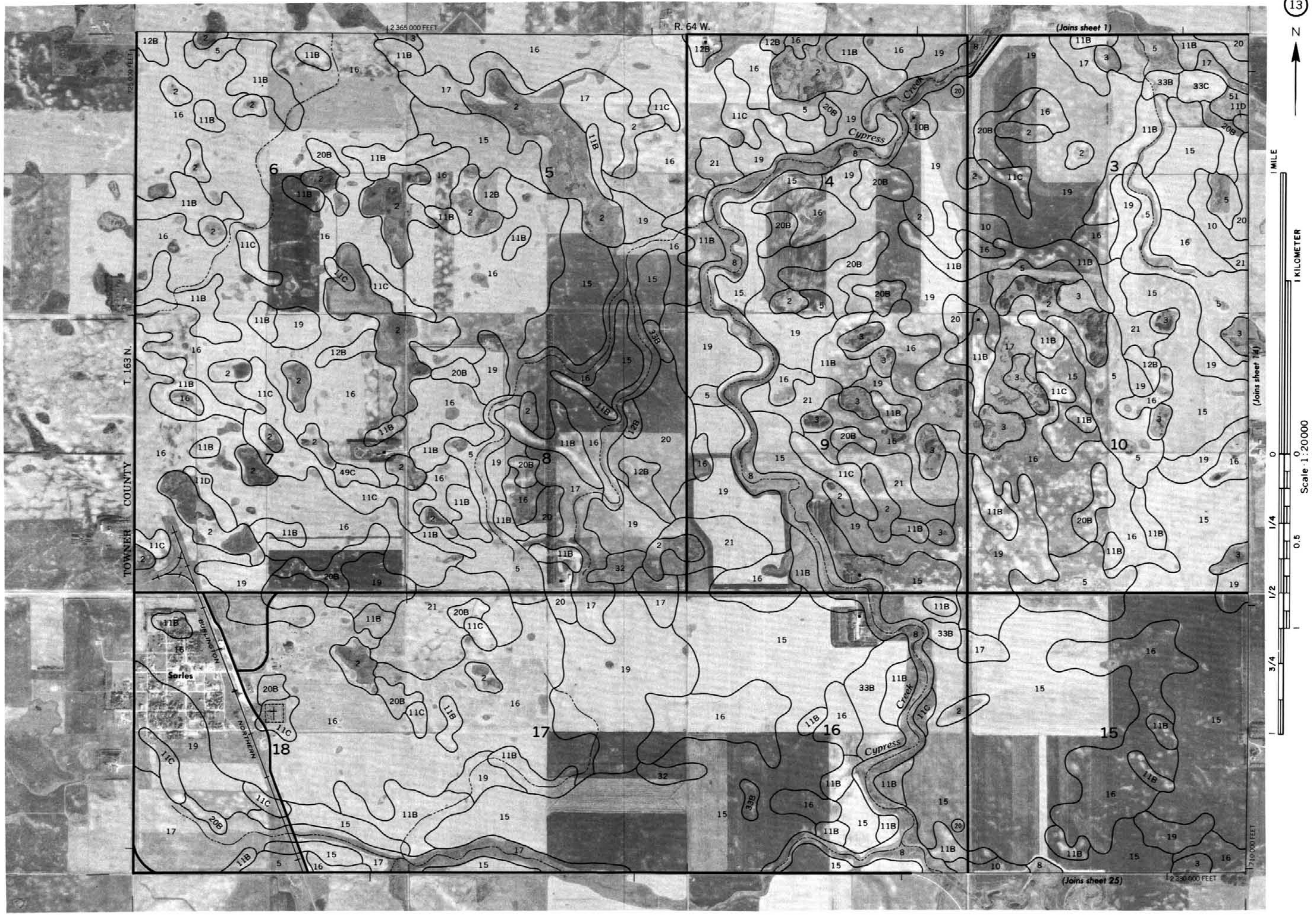
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 3


N
1 MILE
1 KILOMETER
Scale 1:20000
R. 62 W.
2 440 000 FEET
740 000 FEET
T. 164 N.
MANITOBA
CANADA
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 16)
730 000 FEET
2 425 000 FEET
30
29
28
27
31
32
33
34
Snowflake Creek
West


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
R. 58 W.
2 570 000 FEET
MANITOBA
CANADA
PEMBINA
RIVER
27
28
29
30
31
32
33
34
T. 164 N.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 22)
2 550 000 FEET
3
6
7
41
42
44
44B
46F
55
59

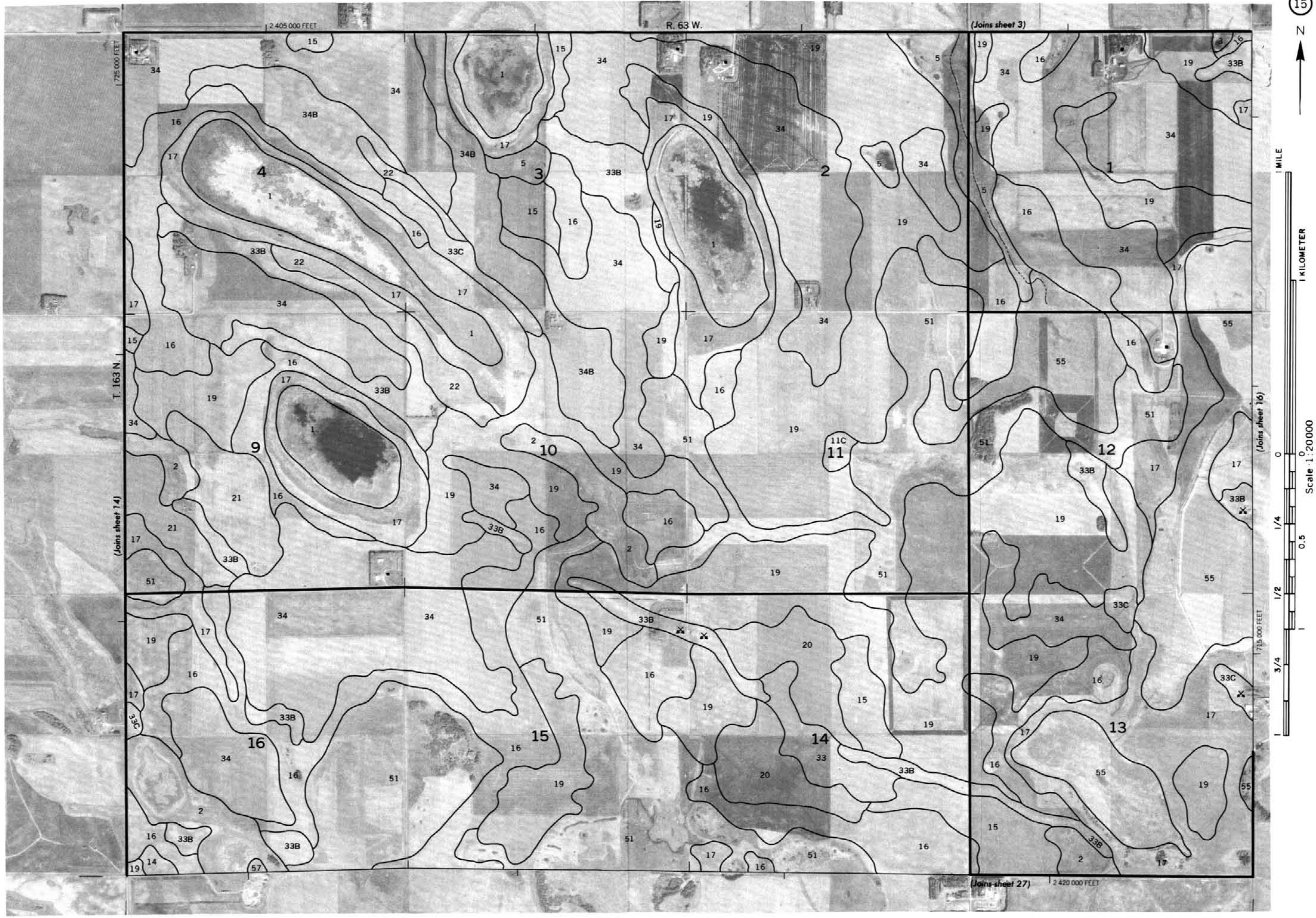

11
N
R. 58 W. | R. 57 W.
2 575 000 FEET
745 000 FEET
MANITOBA CANADA
T. 164 N.
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 23)
735 000 FEET
LITTLE NORTH PEMBINA RIVER
Klemhus Hill
25
26
29
30
31
32
35
36
1 MILE
1 KILOMETER
Scale 1:20000

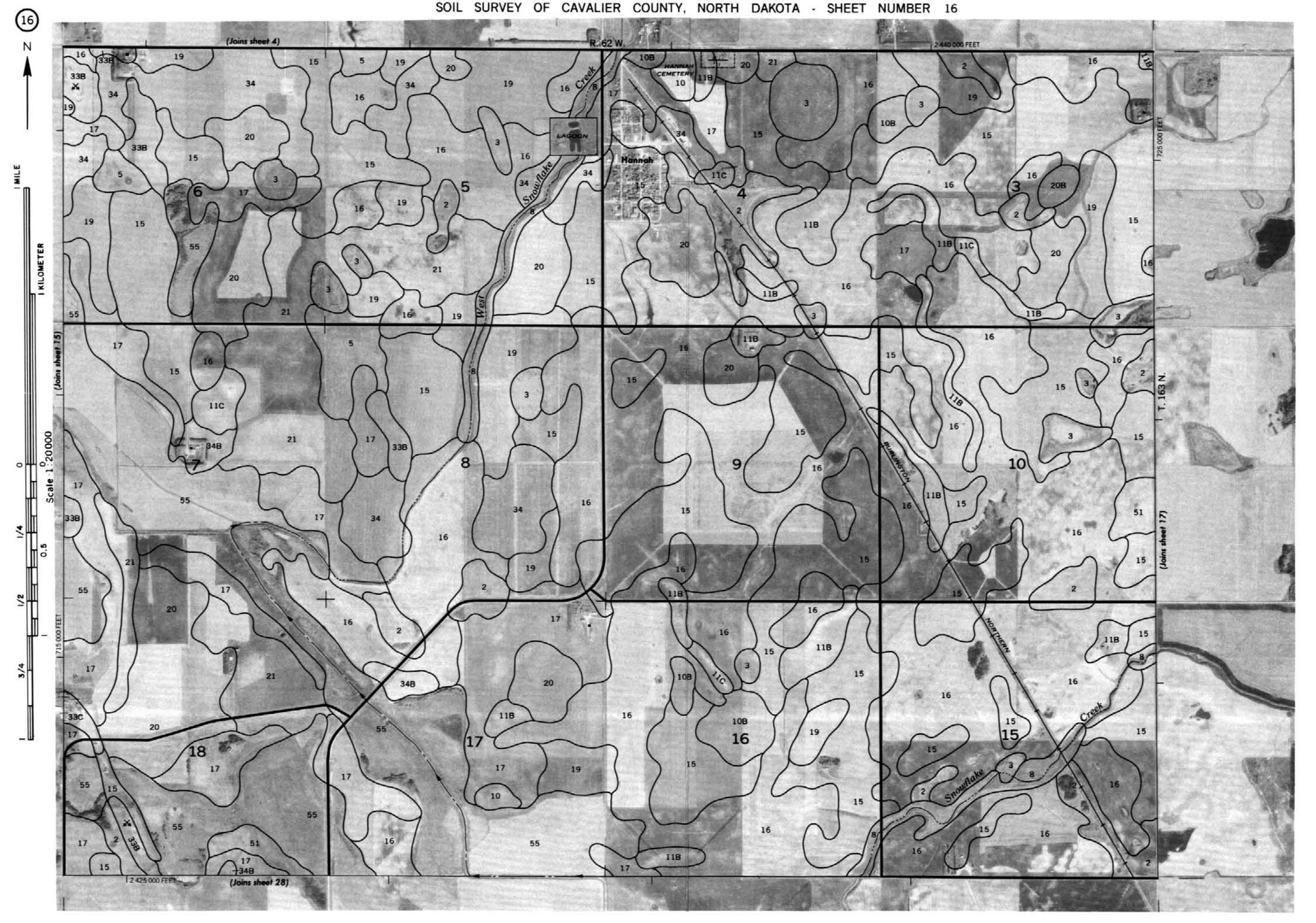
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 12


13
N
R. 64 W.
T. 163 N.
TOWNER COUNTY
(Joins sheet 1)
(Joins sheet 14)
(Joins sheet 25)
2 365 000 FEET
725 000 FEET
2 330 000 FEET
710 000 FEET
Cypress Creek
Sarles
BURLINGTON NORTHERN
1 MILE
1 KILOMETER
Scale 1:20000

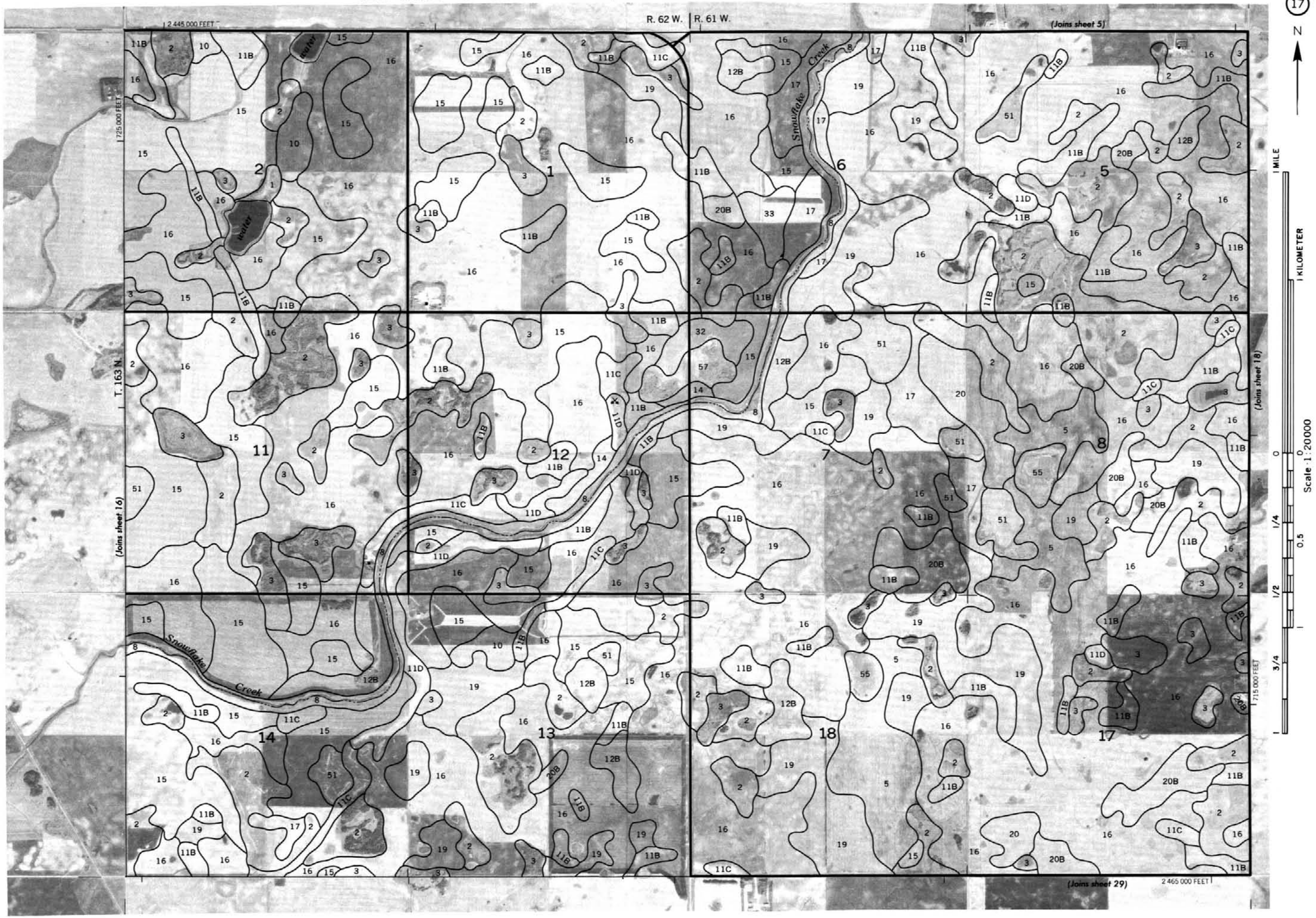
14

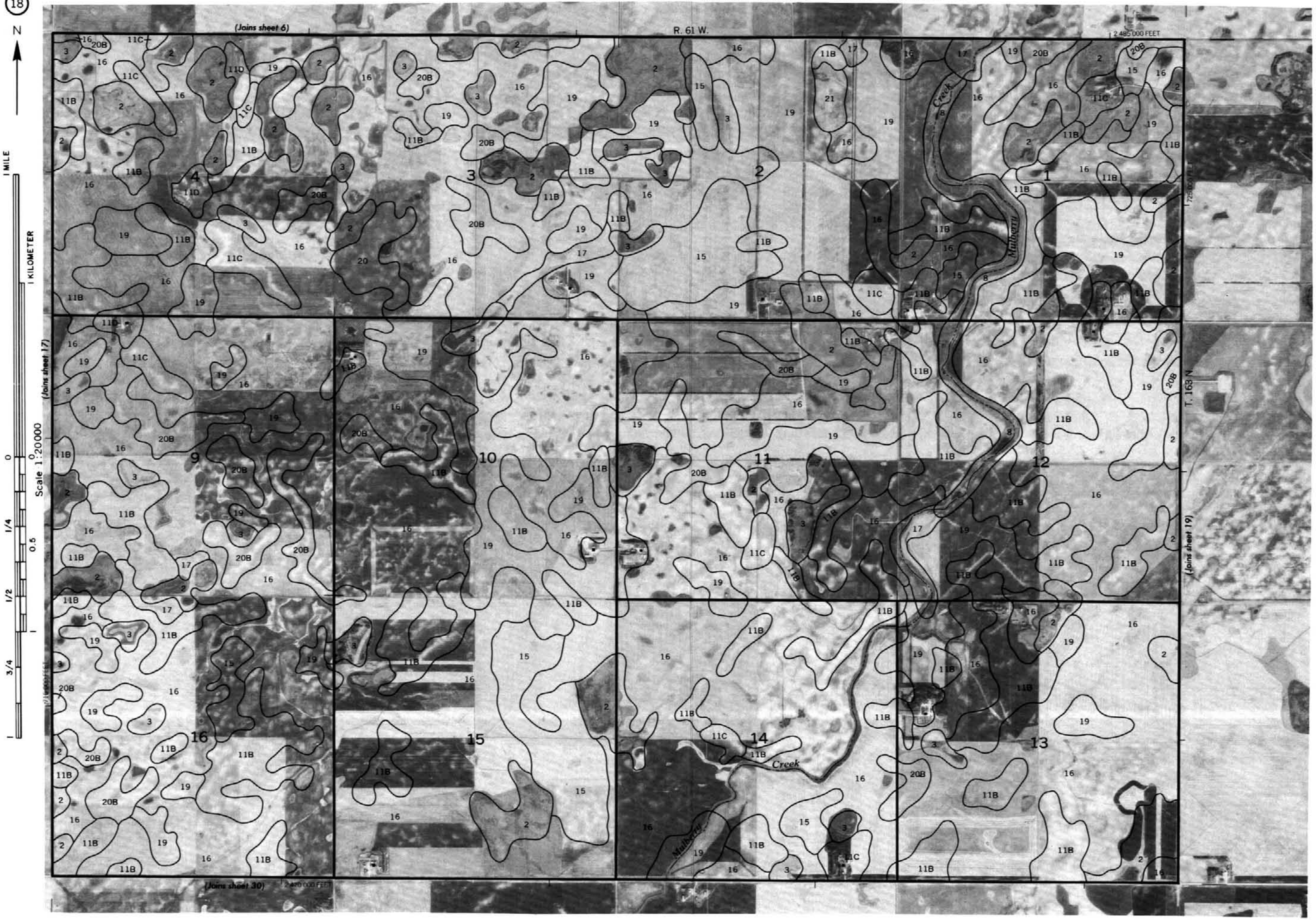
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 14

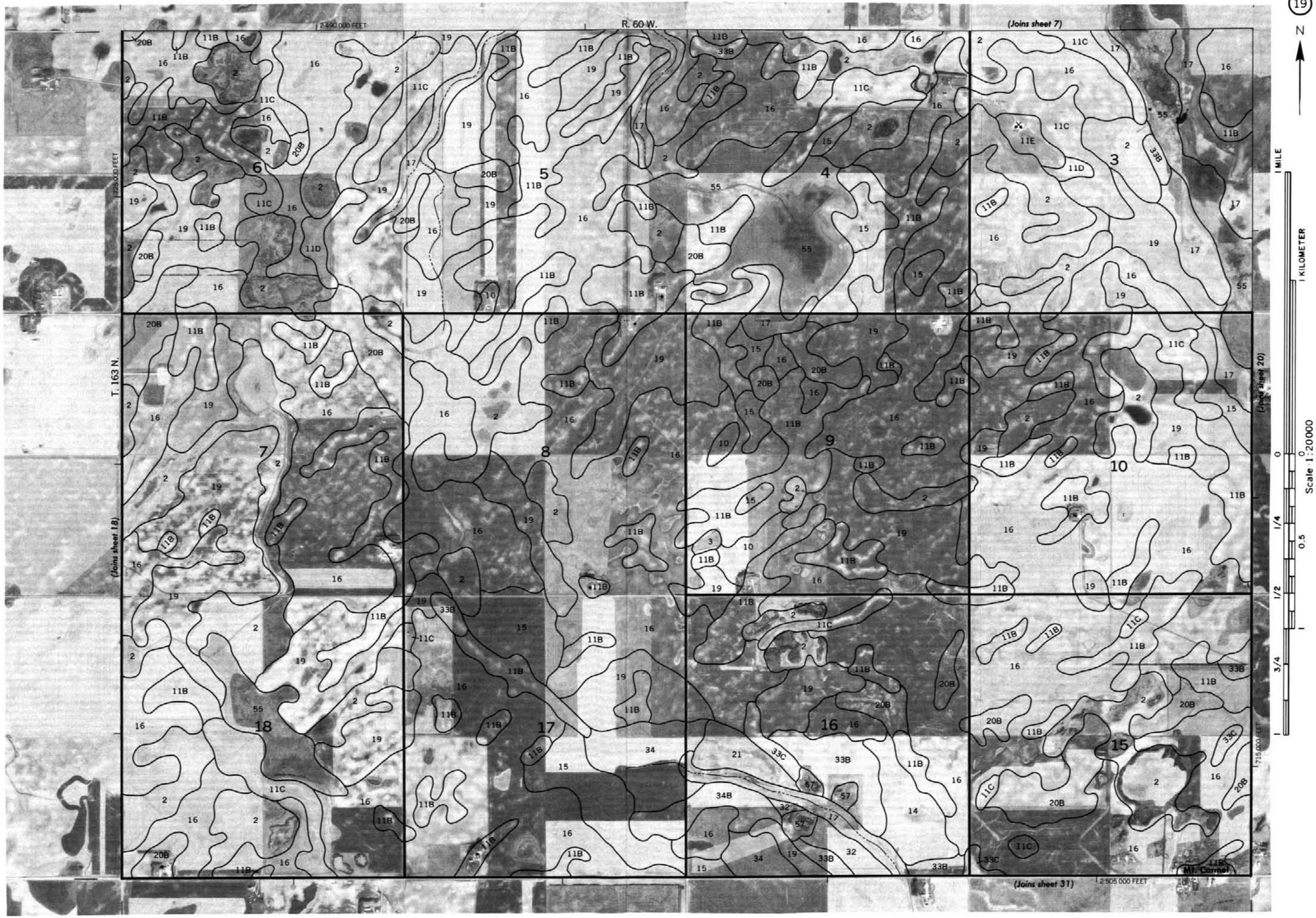

15
(Joins sheet 3)
R. 63 W.
2 405 000 FEET
725 000 FEET
T. 163 N.
(Joins sheet 14)
(Joins sheet 16)
715 000 FEET
(Joins sheet 27)
2 420 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

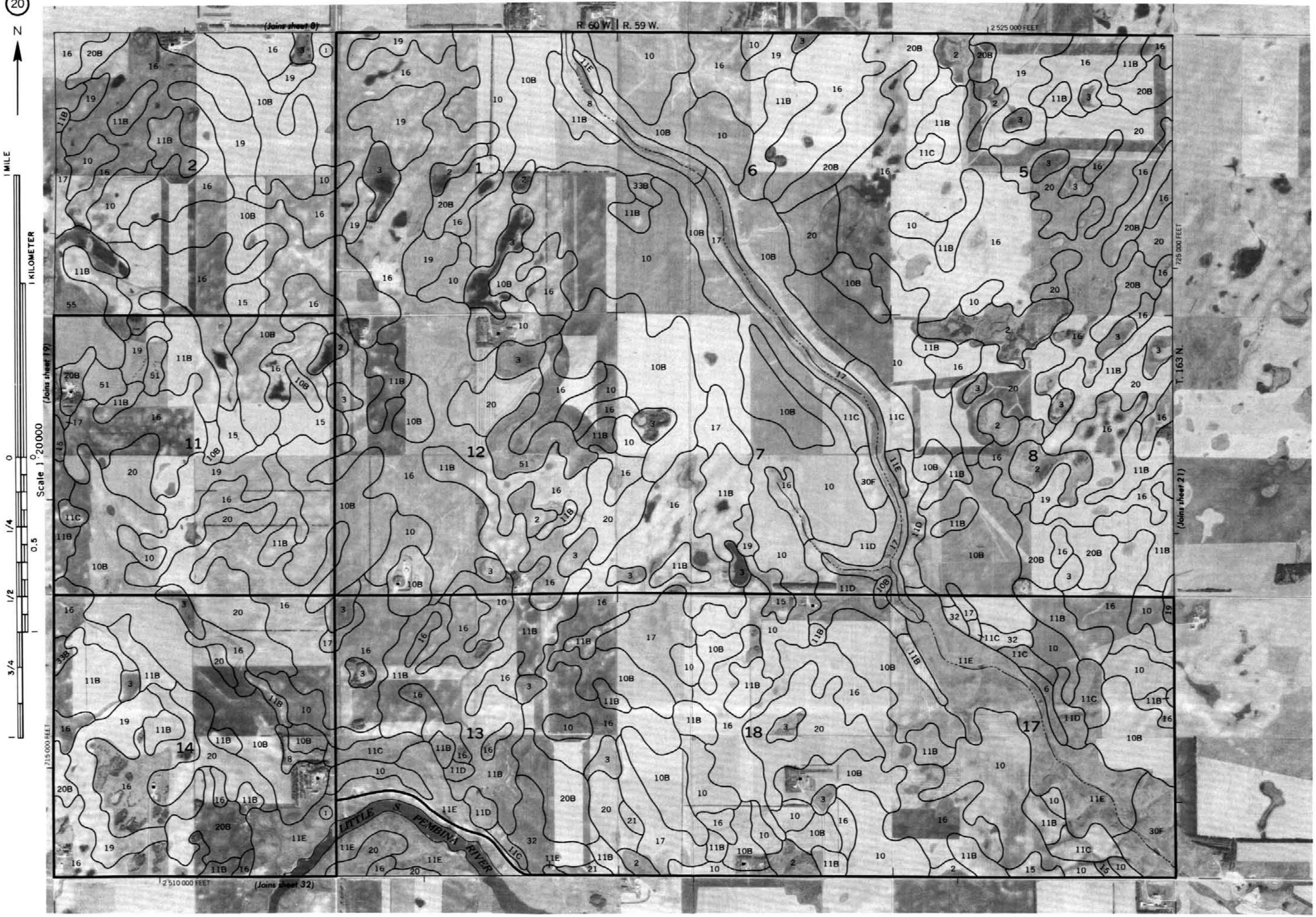

16
N
(Joins sheet 4)
R. 62 W.
2 440 000 FEET
HANNAH CEMETERY
LAGOON
Hannah
West Snowflake Creek
BURLINGTON
NORTHERN
Snowflake Creek
T. 163 N.
725 000 FEET
715 000 FEET
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 28)
2 425 000 FEET
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0
0.5
1

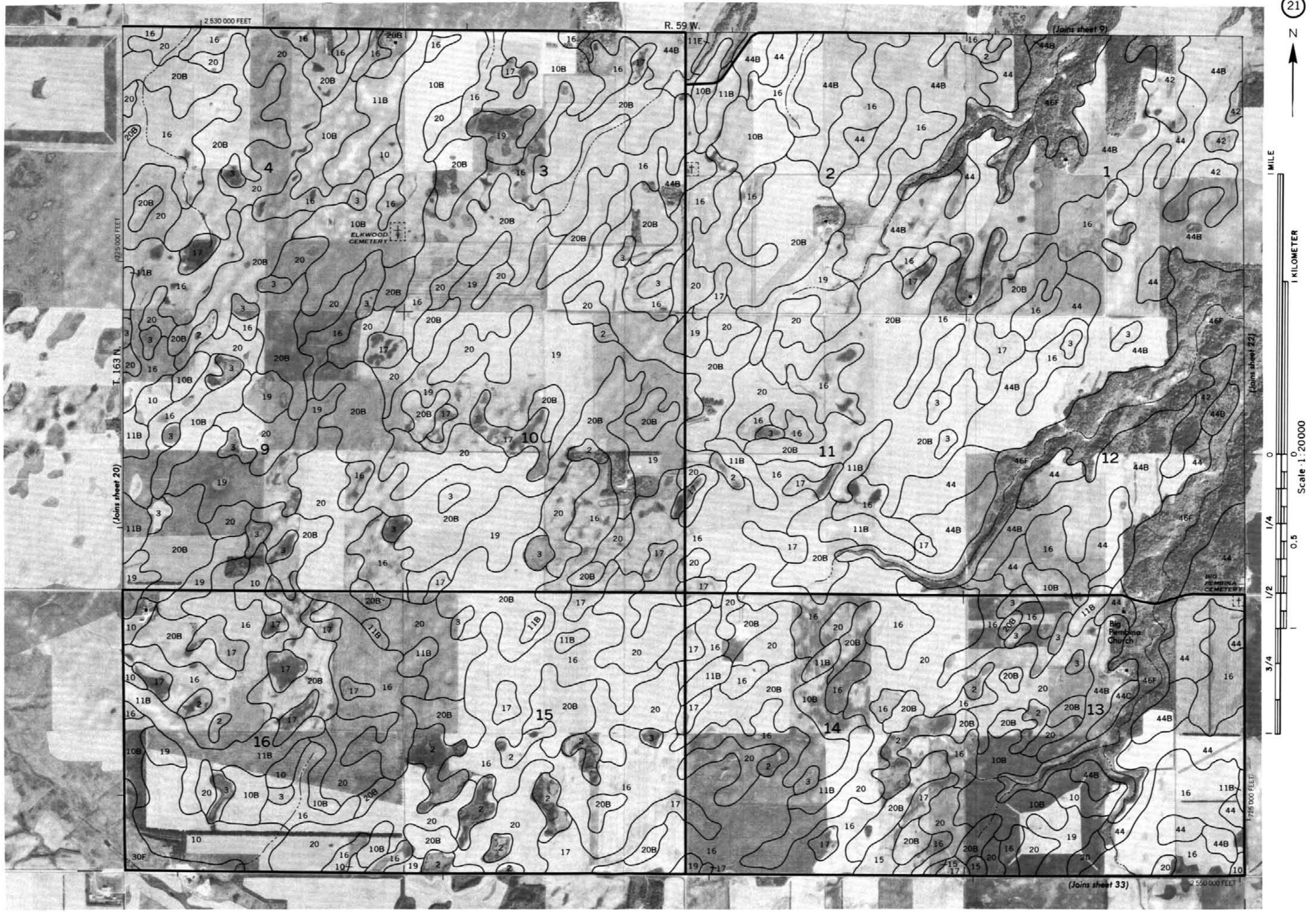
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 17

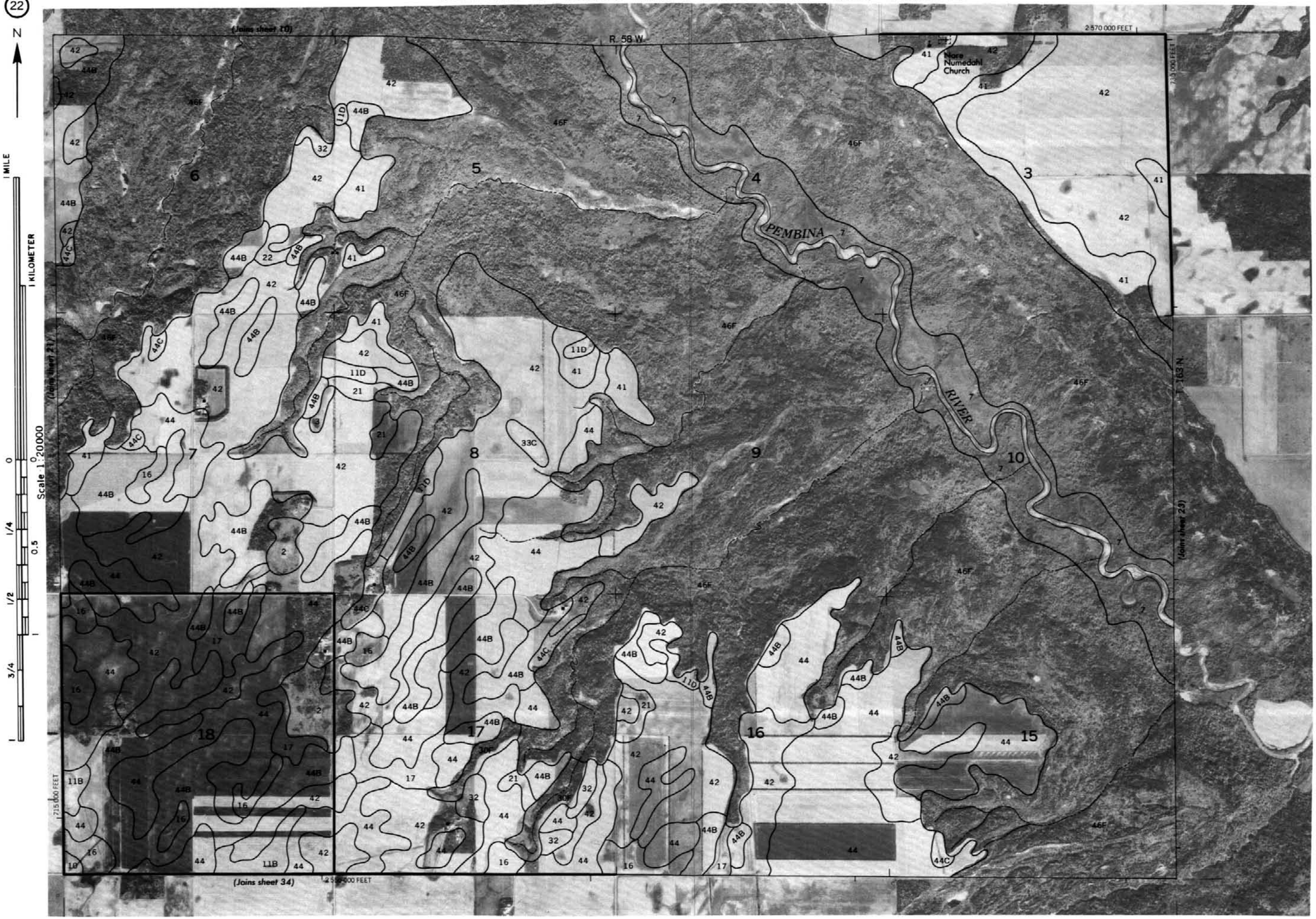


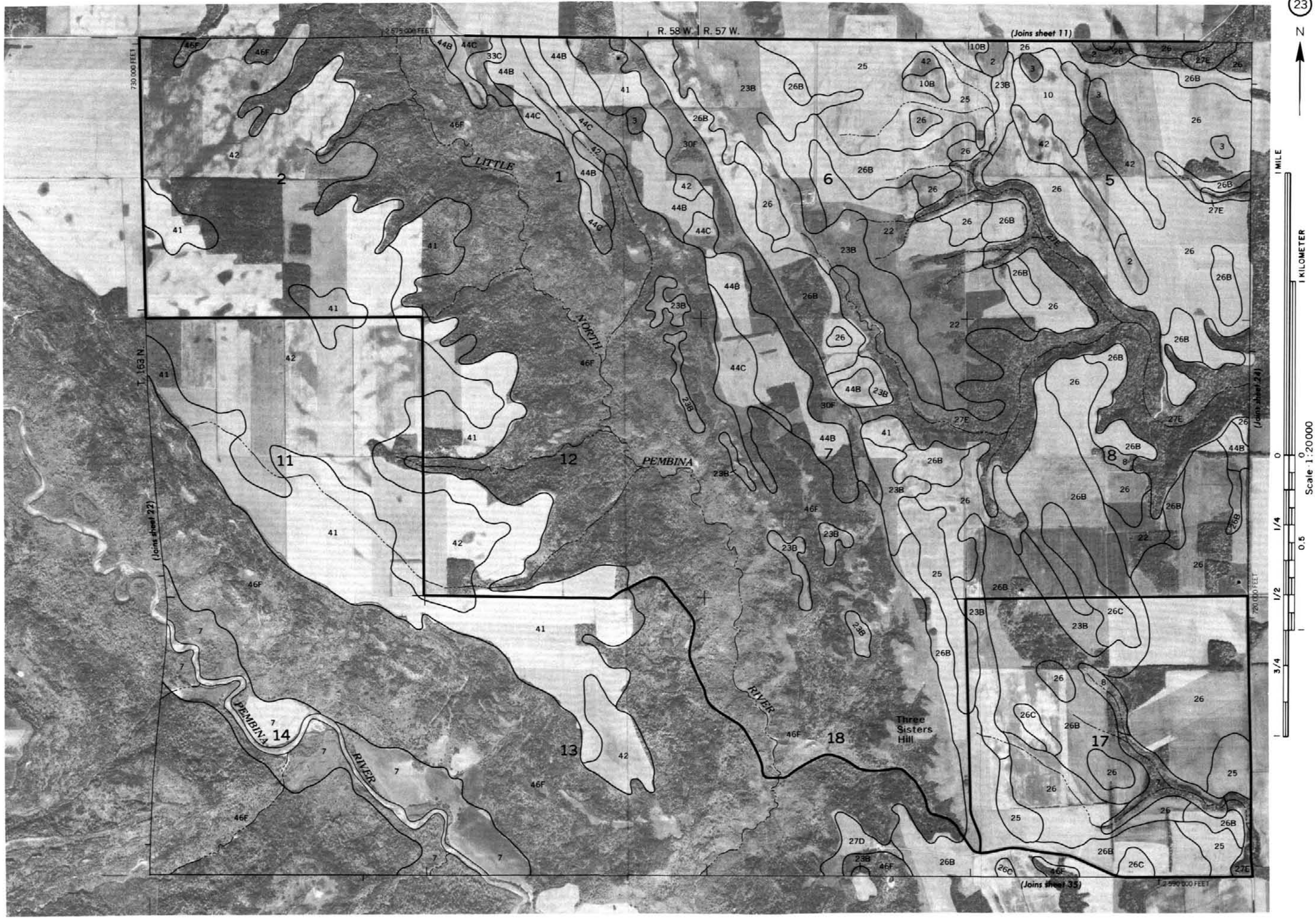

18
N
(Joins sheet 6)
R. 61 W.
2 485 000 FEET
T. 163 N.
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 30)
2 420 000 FEET
Mulberry
Creek
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
1
2
3
4
9
10
11
12
13
14
15
16


R. 60 W.
T. 163 N.
(Joins sheet 7)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 31)
2 490 000 FEET
2 505 000 FEET
215 000 FEET
Mt. Carmel
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

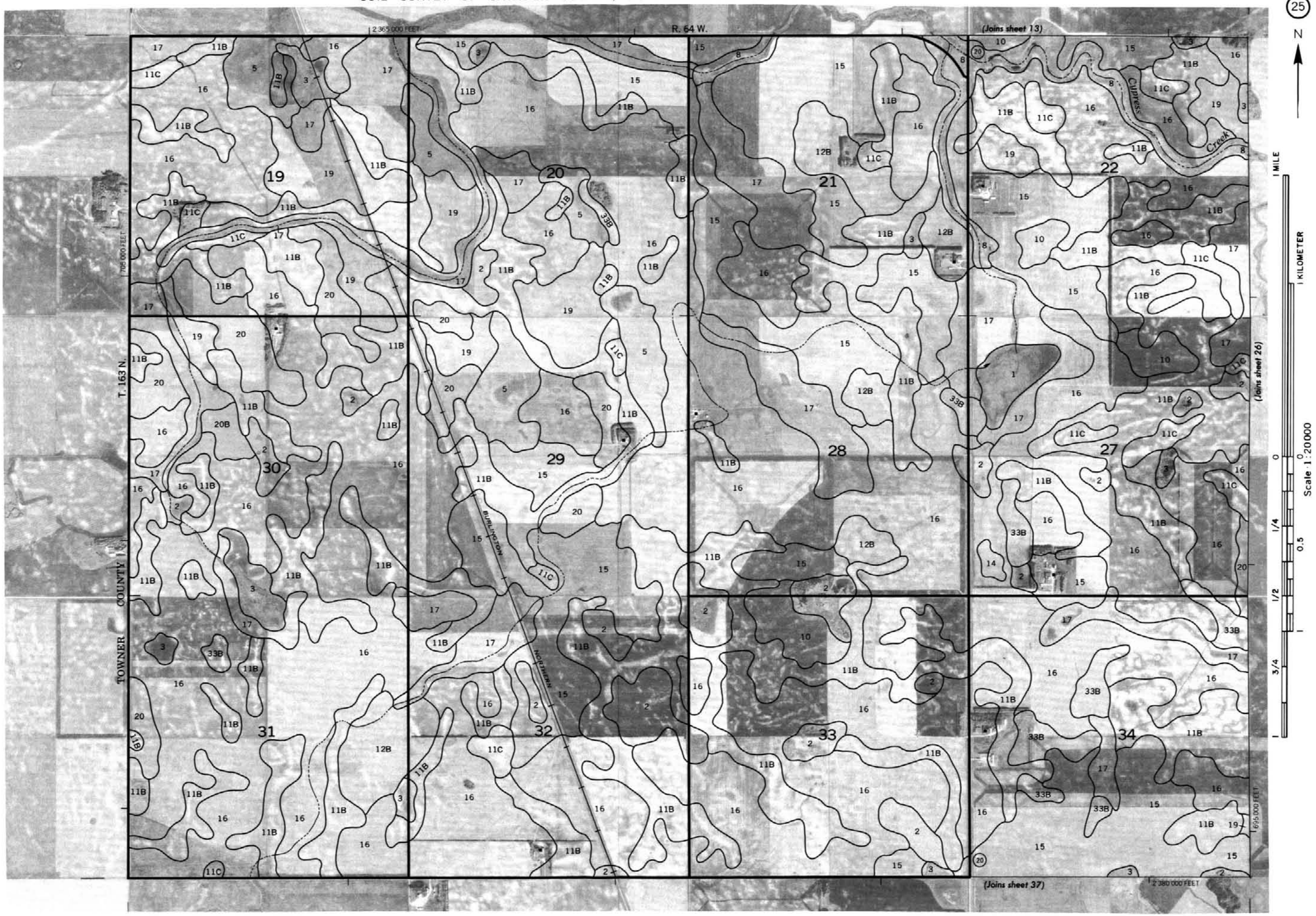

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 8)
R. 60 W. | R. 59 W.
2 525 000 FEET
725 000 FEET
T. 163 N.
(Joins sheet 21)
(Joins sheet 19)
715 000 FEET
2 510 000 FEET
(Joins sheet 32)
LITTLE S. PEMBINA RIVER


21
N
2 530 000 FEET
R. 59 W.
(Joins sheet 9)
T. 163 N.
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 33)
ELKWOOD CEMETERY
BIG PEMBINA CEMETERY
Big Pembina Church
2 550 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

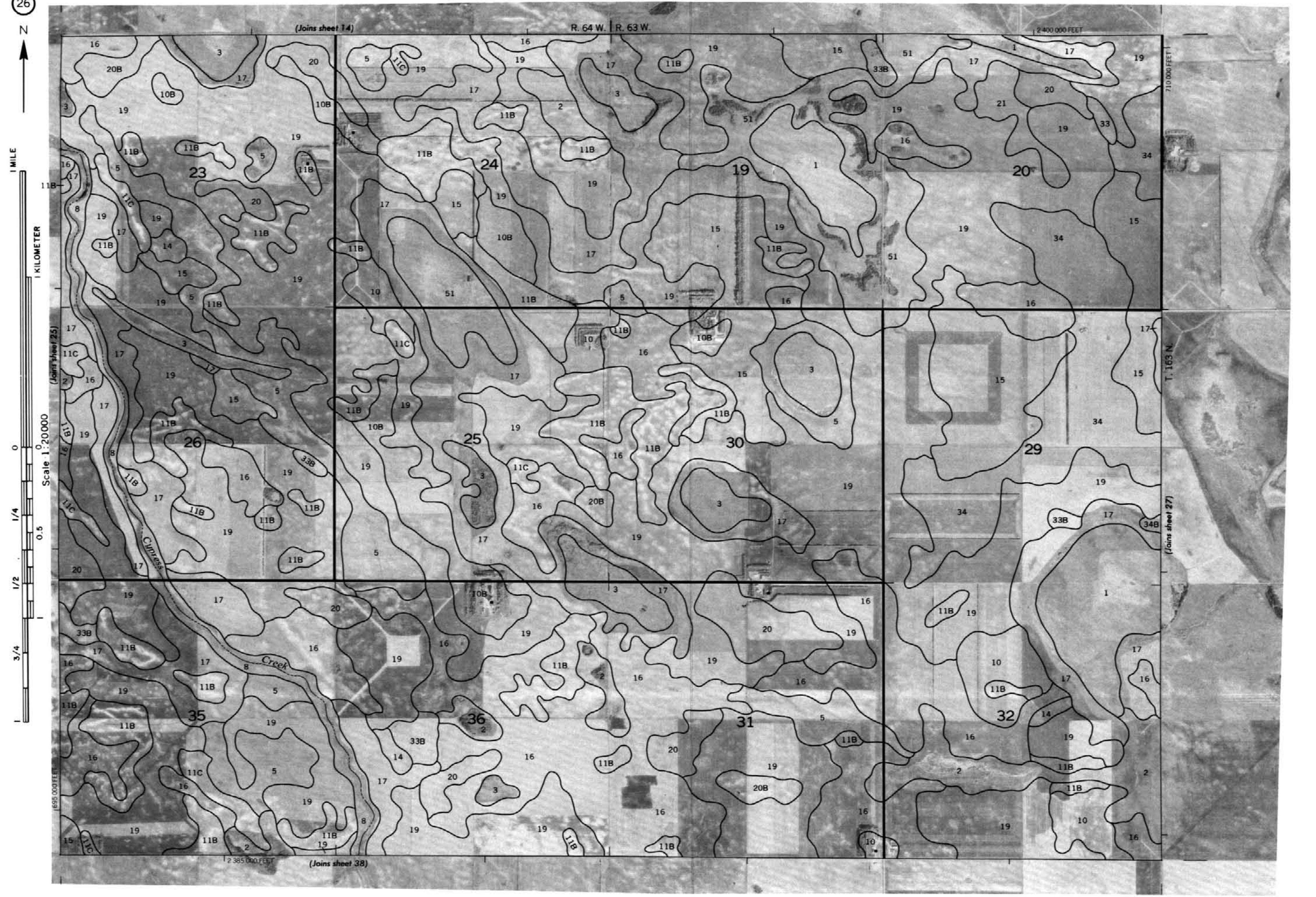

22
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 10)
R. 58 W.
2 570 000 FEET
735 000 FEET
Nora Numedahl Church
PEMBINA
RIVER
T. 163 N.
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 34)
2 550 000 FEET
715 000 FEET


23
N
(Joins sheet 11)
R. 58 W.
R. 57 W.
2 575 000 FEET
730 000 FEET
T. 163 N.
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 35)
720 000 FEET
2 590 000 FEET
LITTLE
NORTH
PEMBINA
RIVER
PEMBINA
RIVER
Three Sisters Hill
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20000
2
3
7
8
10
10B
22
23B
25
26
26B
26C
27D
27E
30F
33C
41
42
44B
44C
46F

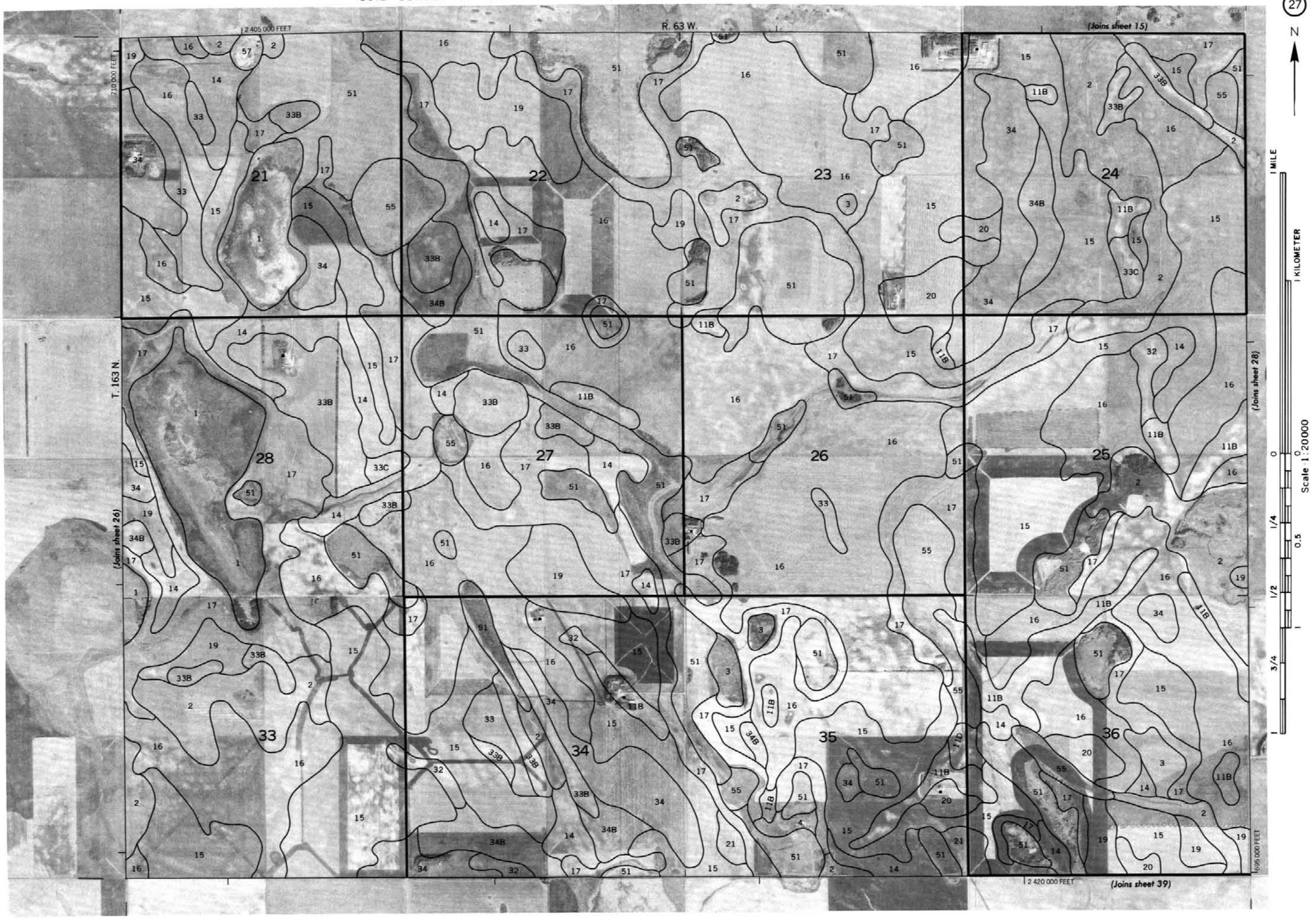

24
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 12)
R. 57 W.
2 610 000 FEET
730 000 FEET
T. 163 N.
PEMBINA COUNTY
(Joins sheet 23)
720 000 FEET
2 595 000 FEET
(Joins sheet 36)

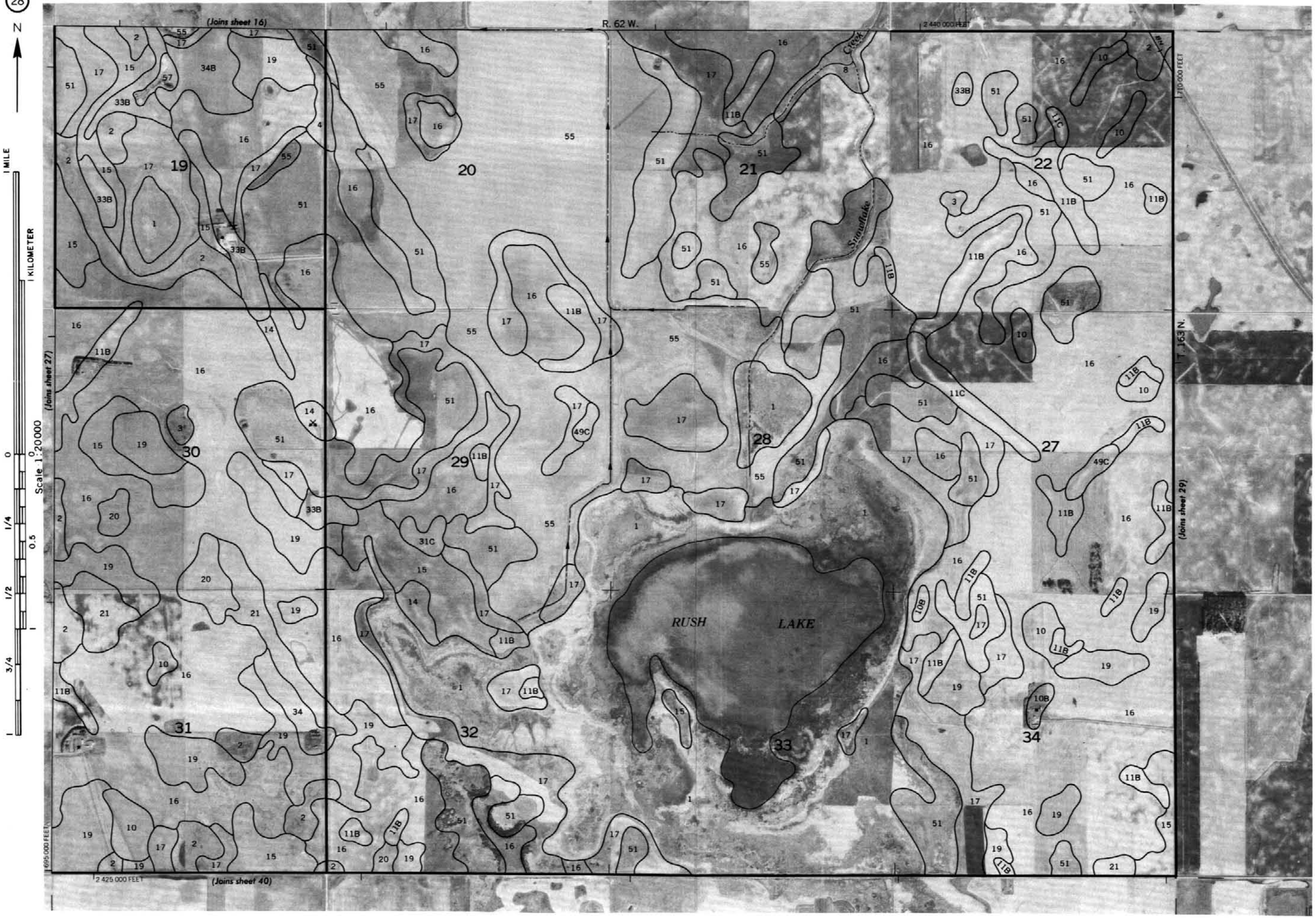

25
N
R. 64 W.
(Joins sheet 13)
2 365 000 FEET
705 000 FEET
T. 163 N.
TOWNER COUNTY
Cypress Creek
BURLINGTON NORTHERN
(Joins sheet 26)
695 000 FEET
(Joins sheet 37)
2 380 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
19
20
21
22
30
29
28
27
31
32
33
34

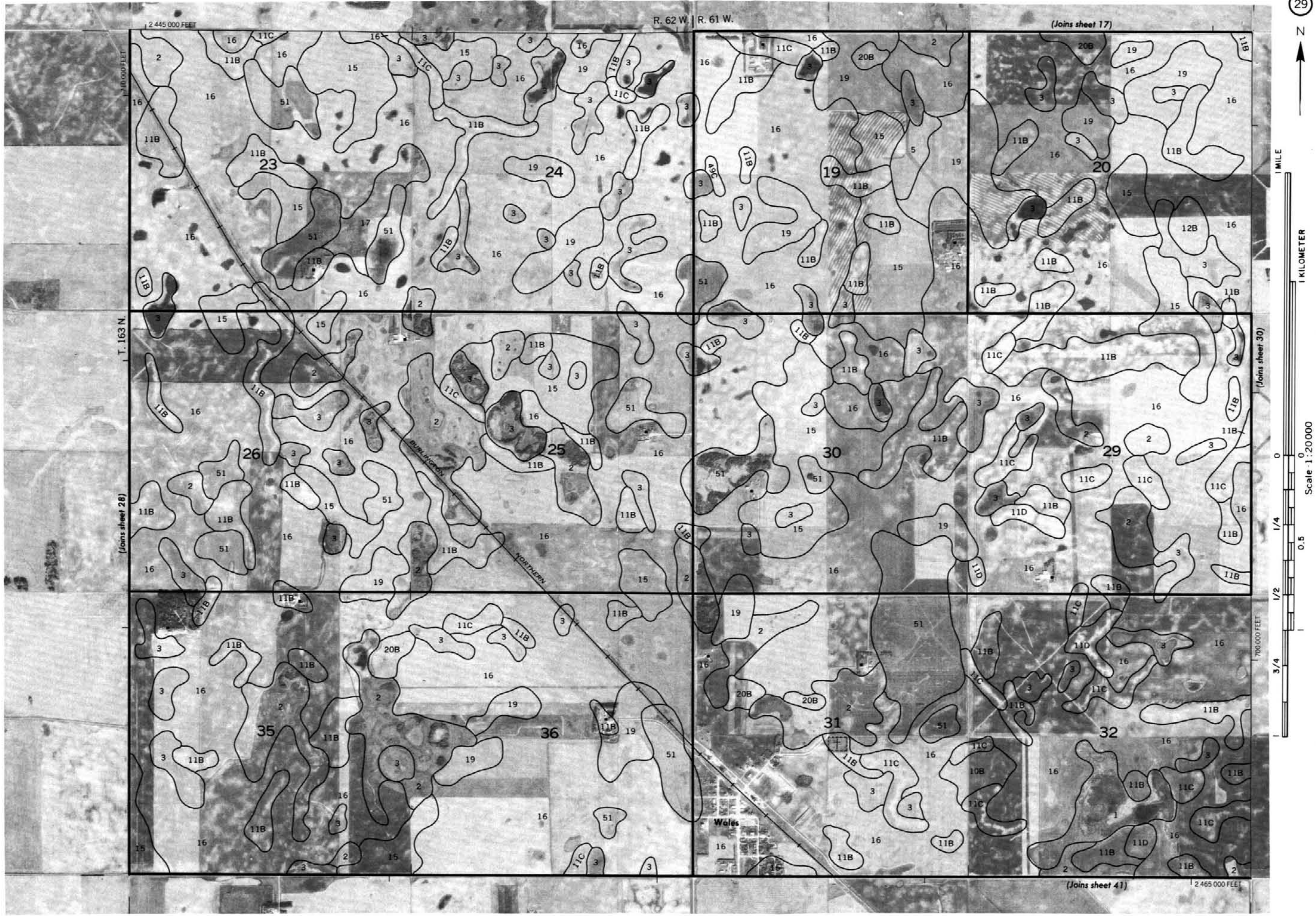
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 26



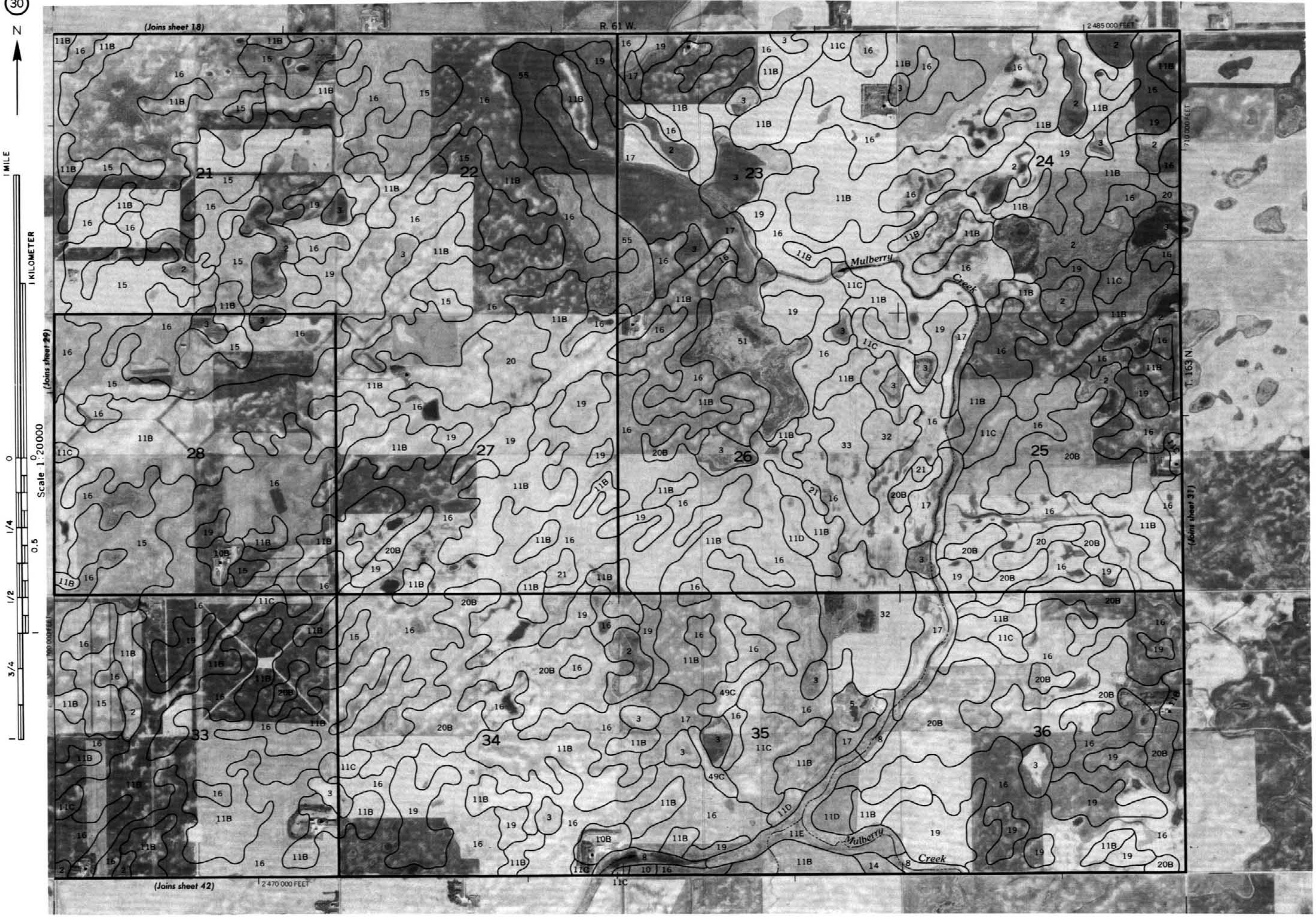
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 27

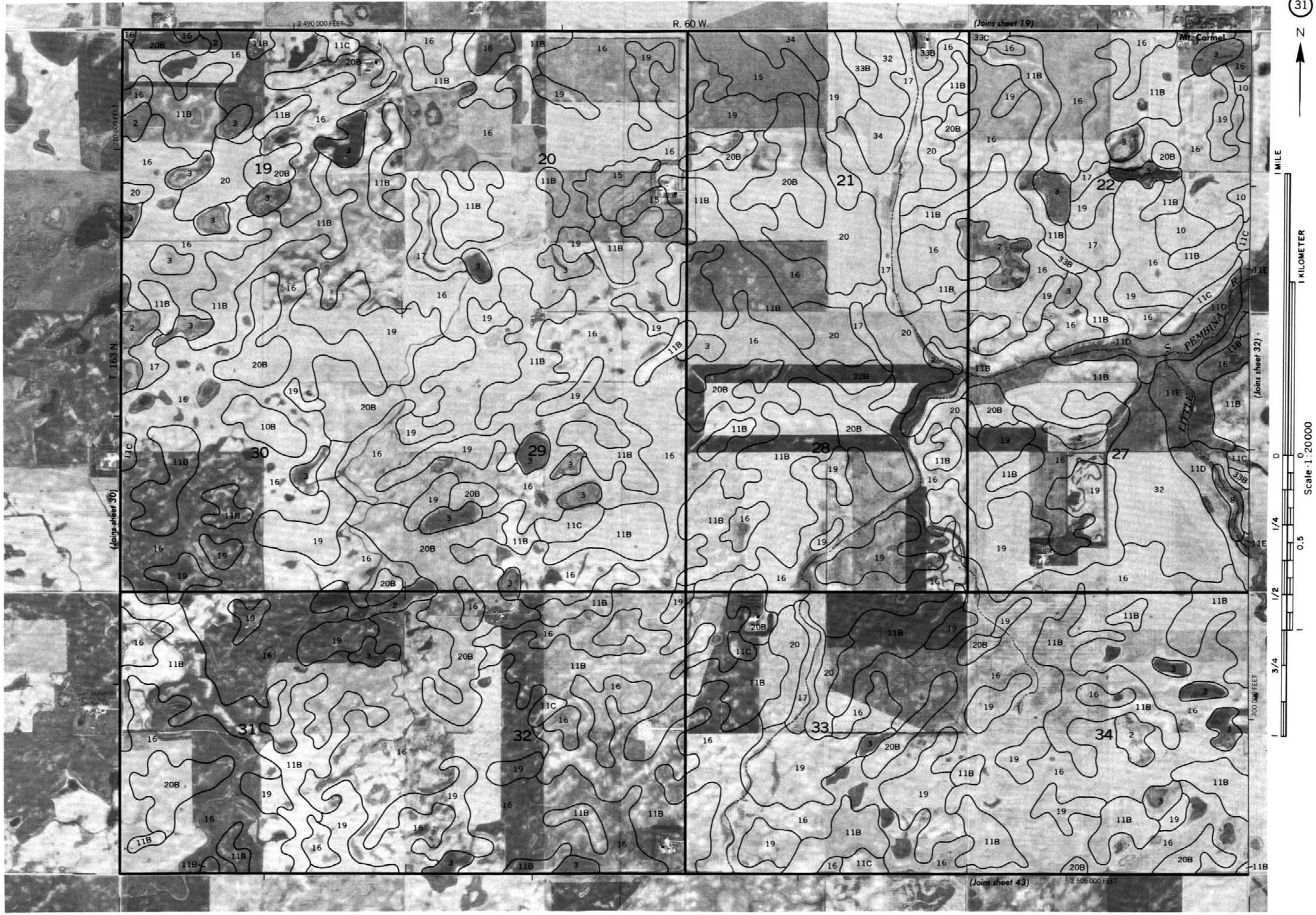


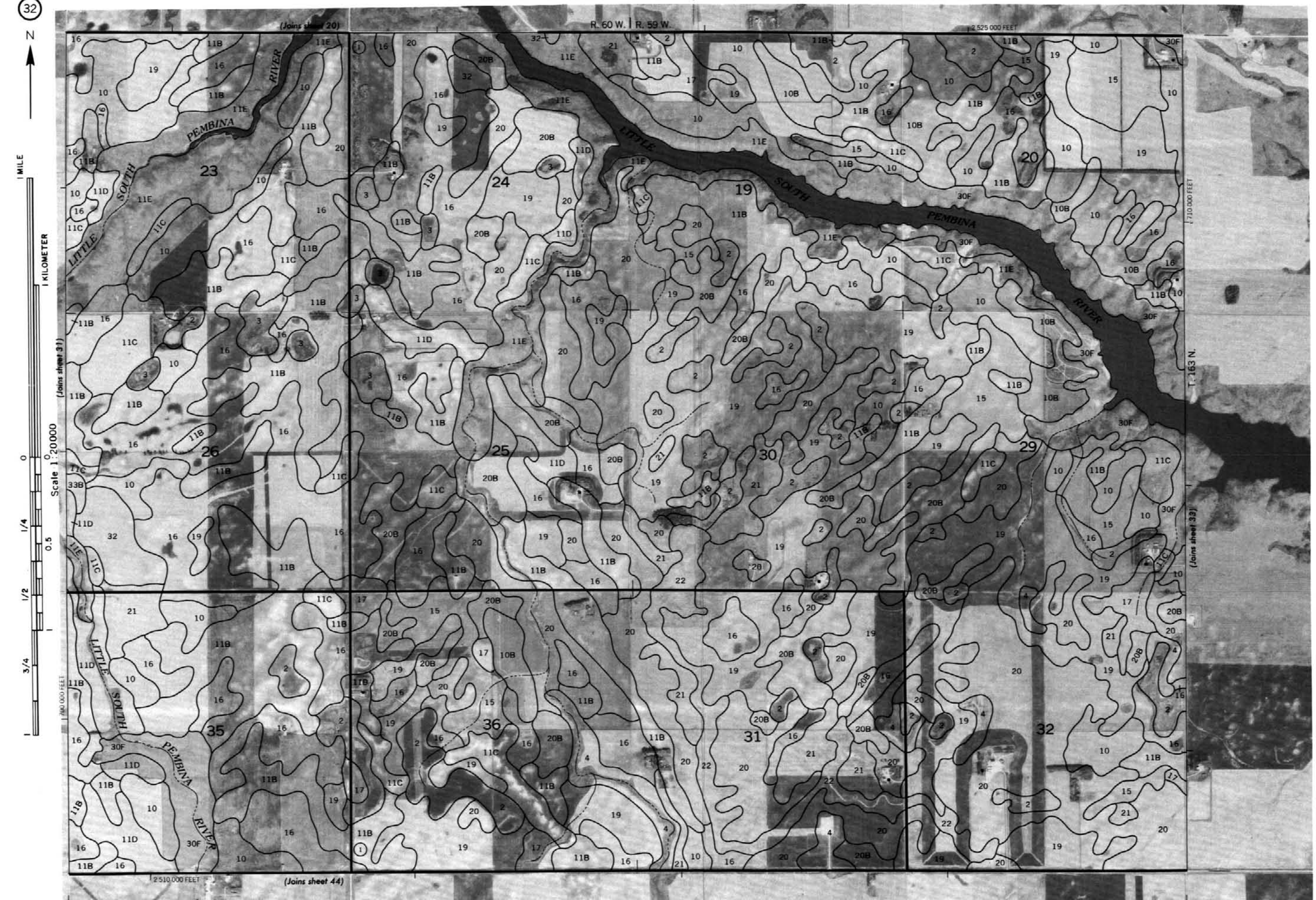

N
1 MILE
1 KILOMETER
Scale 1:20 000
(Joins sheet 16)
R. 62 W.
2 440 000 FEET
710 000 FEET
Creek
Snowflake
T. 163 N.
(Joins sheet 27)
(Joins sheet 29)
RUSH
LAKE
695 000 FEET
2 425 000 FEET
(Joins sheet 40)

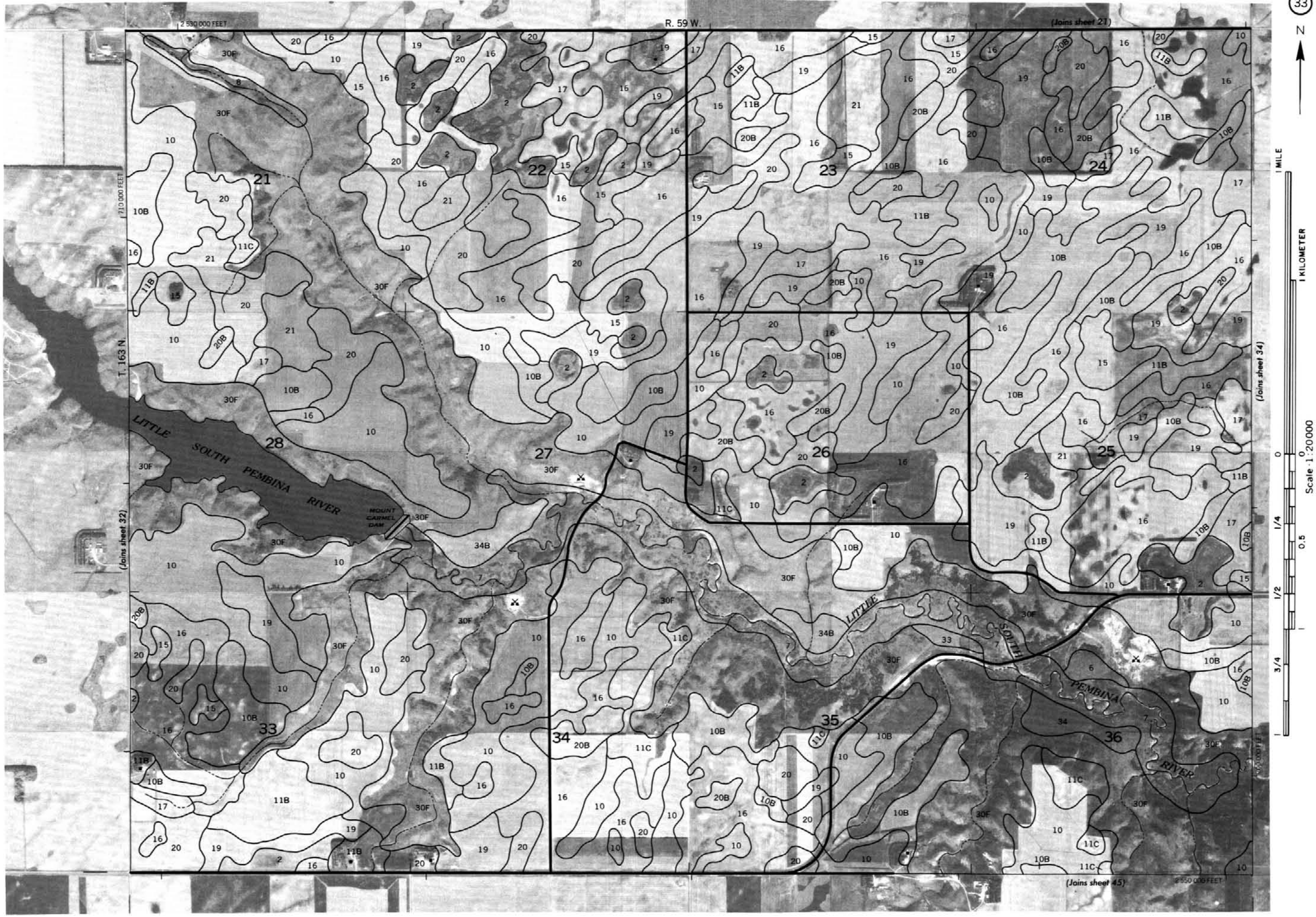

29
N
2 445 000 FEET
R. 62 W. | R. 61 W.
(Joins sheet 17)
T. 163 N.
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 41)
2 465 000 FEET
700 000 FEET
BURLINGTON NORTHERN
Wales
23
24
19
20
26
25
30
29
35
36
31
32
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20 000

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 30

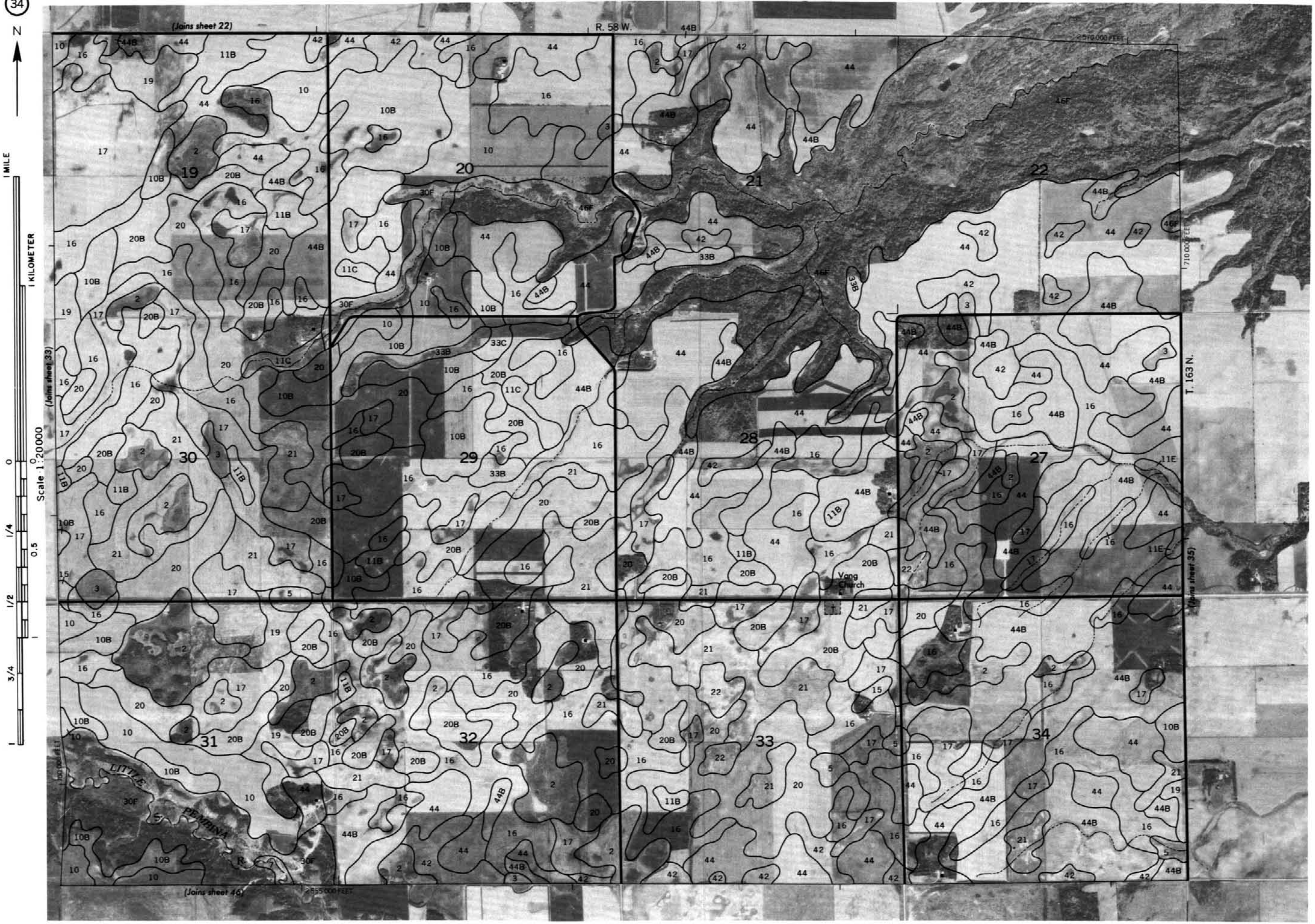


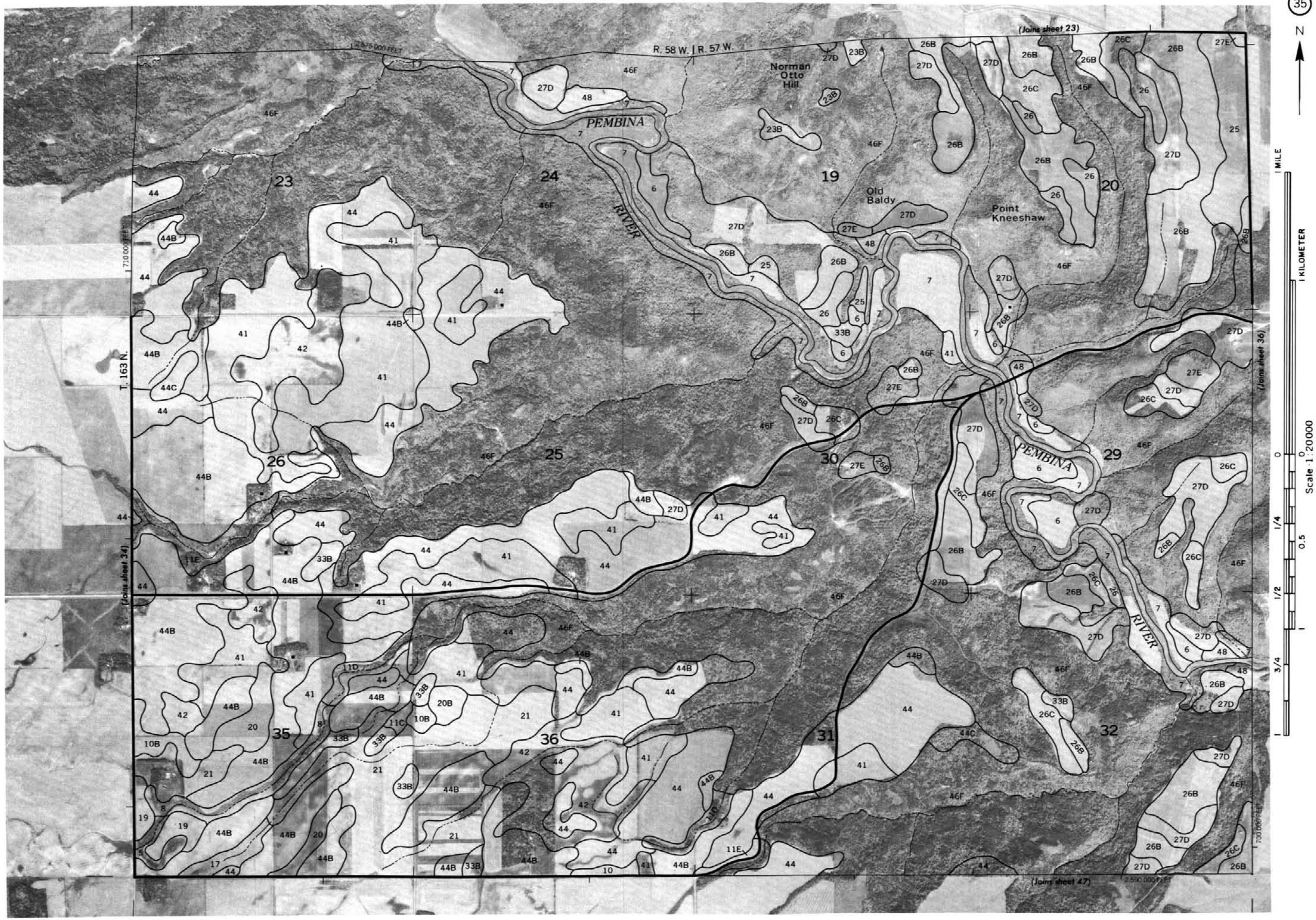

31
N
R. 60 W.
(Joins sheet 19)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 43)
T. 163 N.
2 490 000 FEET
2 505 000 FEET
210 000 FEET
200 000 FEET
Mt. Carmel
S. PEMBINA R.
LITTLE
1 MILE
1 KILOMETER
Scale 1:20000


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 20)
R. 60 W.
R. 59 W.
2 525 000 FEET
710 000 FEET
700 000 FEET
T. 163 N.
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 44)
2 510 000 FEET
LITTLE SOUTH PEMBINA RIVER
LITTLE SOUTH PEMBINA RIVER
LITTLE SOUTH PEMBINA RIVER
23
24
19
20
26
25
30
29
35
36
31
32

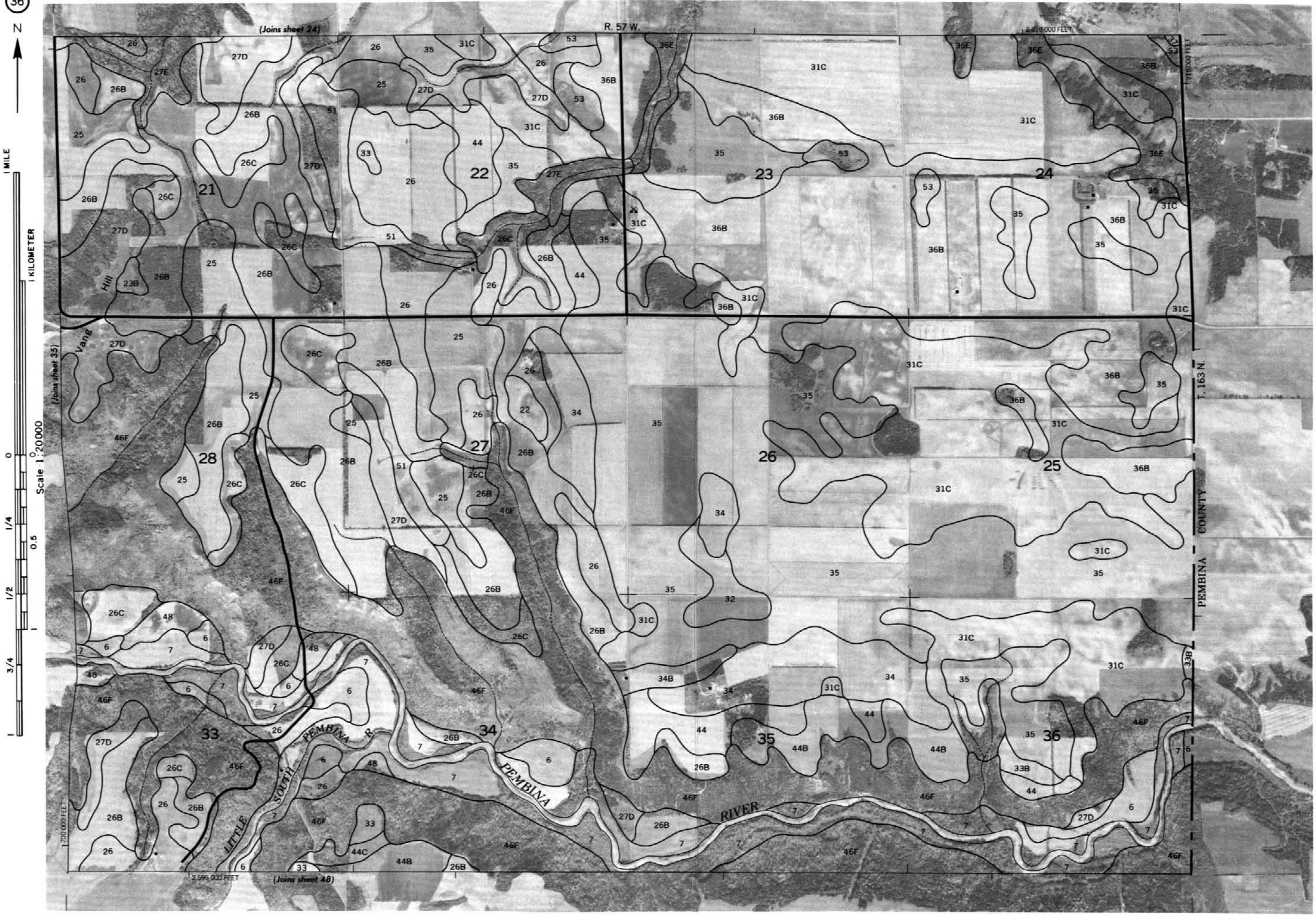


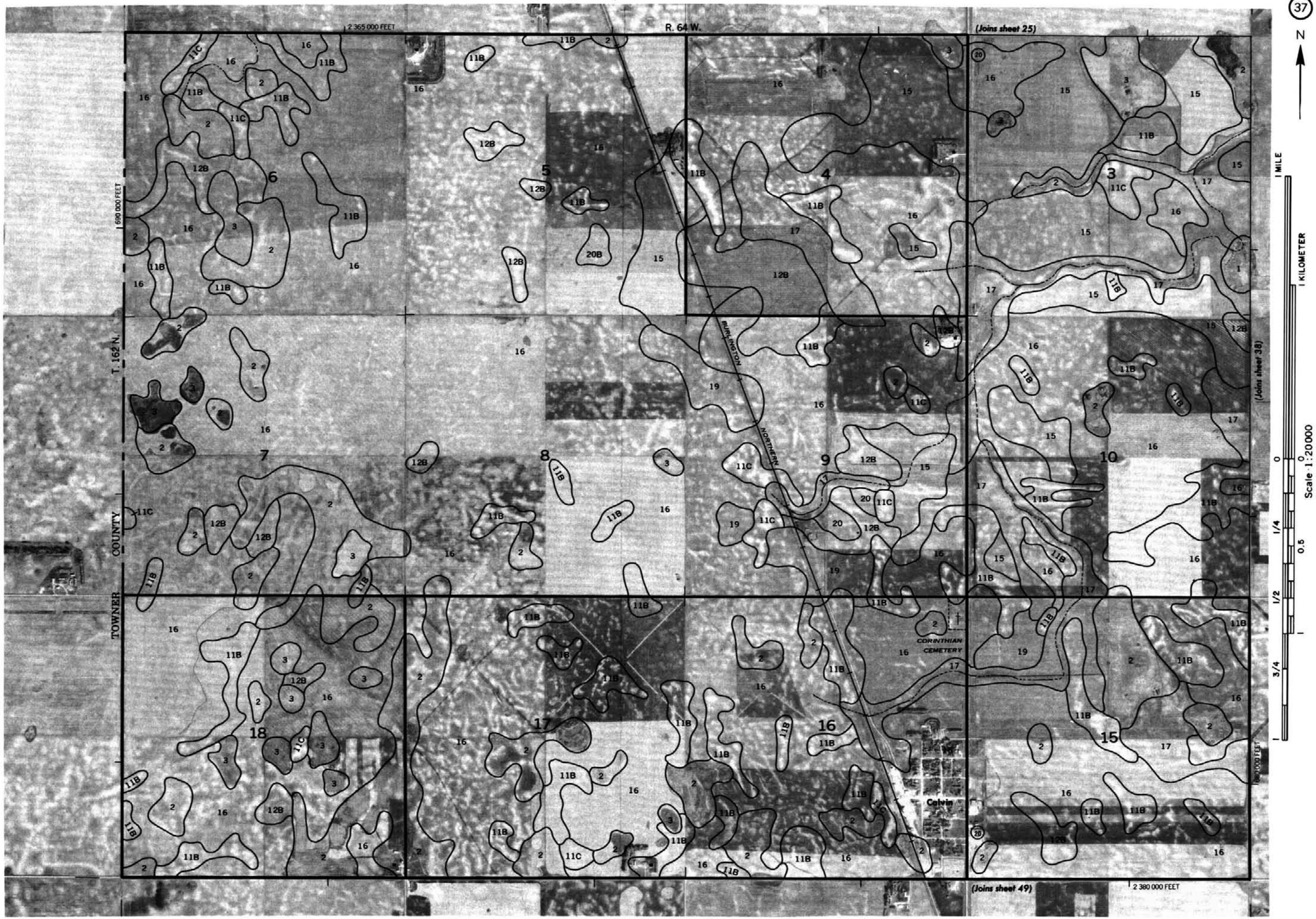
2 530 000 FEET
R. 59 W.
(Joins sheet 21)
710 000 FEET
T. 163 N.
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 45)
2 550 000 FEET
LITTLE SOUTH PEMBINA RIVER
MOUNT CARMEL DAM
21
22
23
24
25
26
27
28
33
34
35
36
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

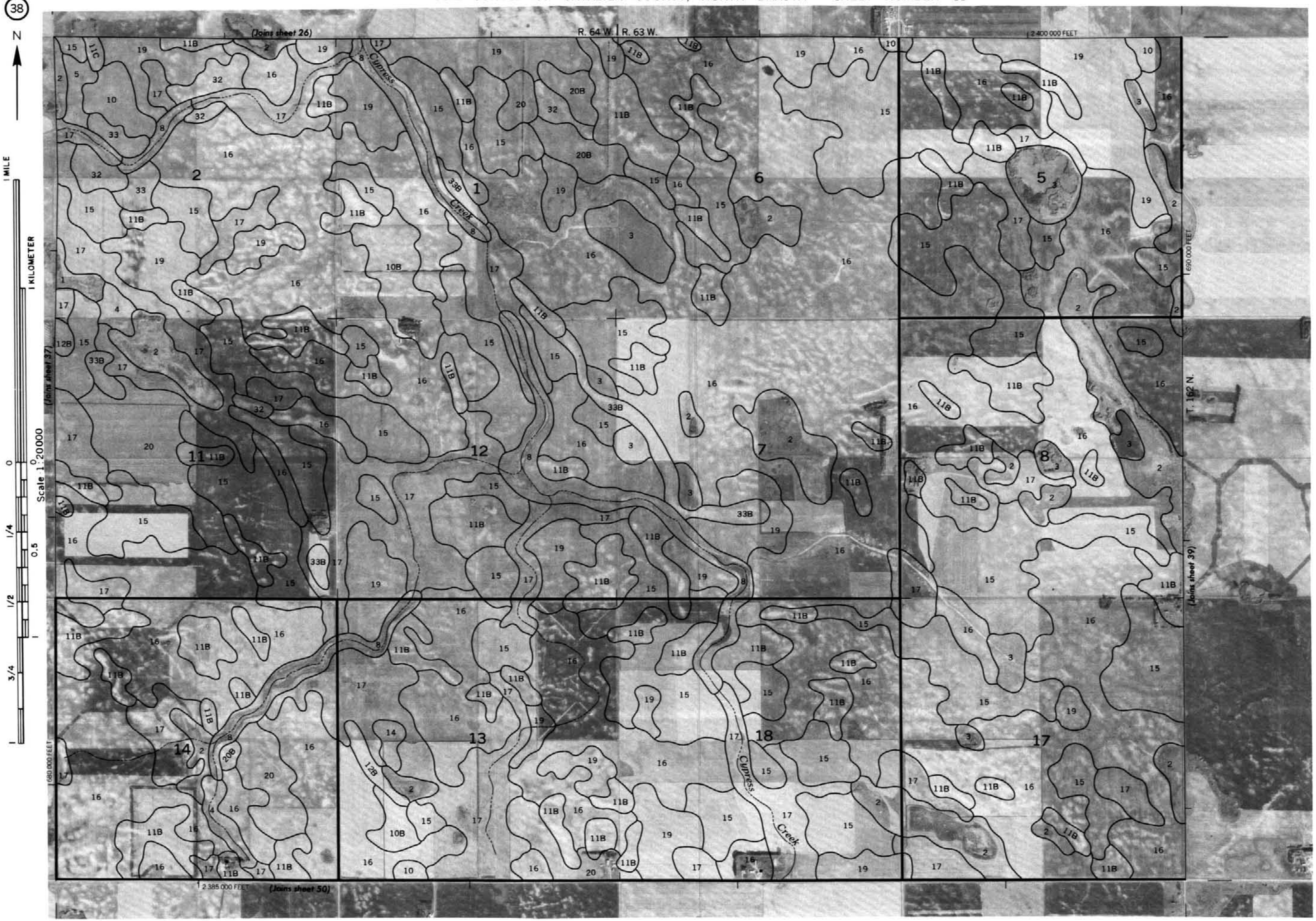

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 22)
R. 58 W.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 46)
T. 163 N.
Vang Church
LITTLE PEMBINA R.
2 570 000 FEET
2 555 000 FEET
710 000 FEET
19
20
21
22
27
28
29
30
31
32
33
34

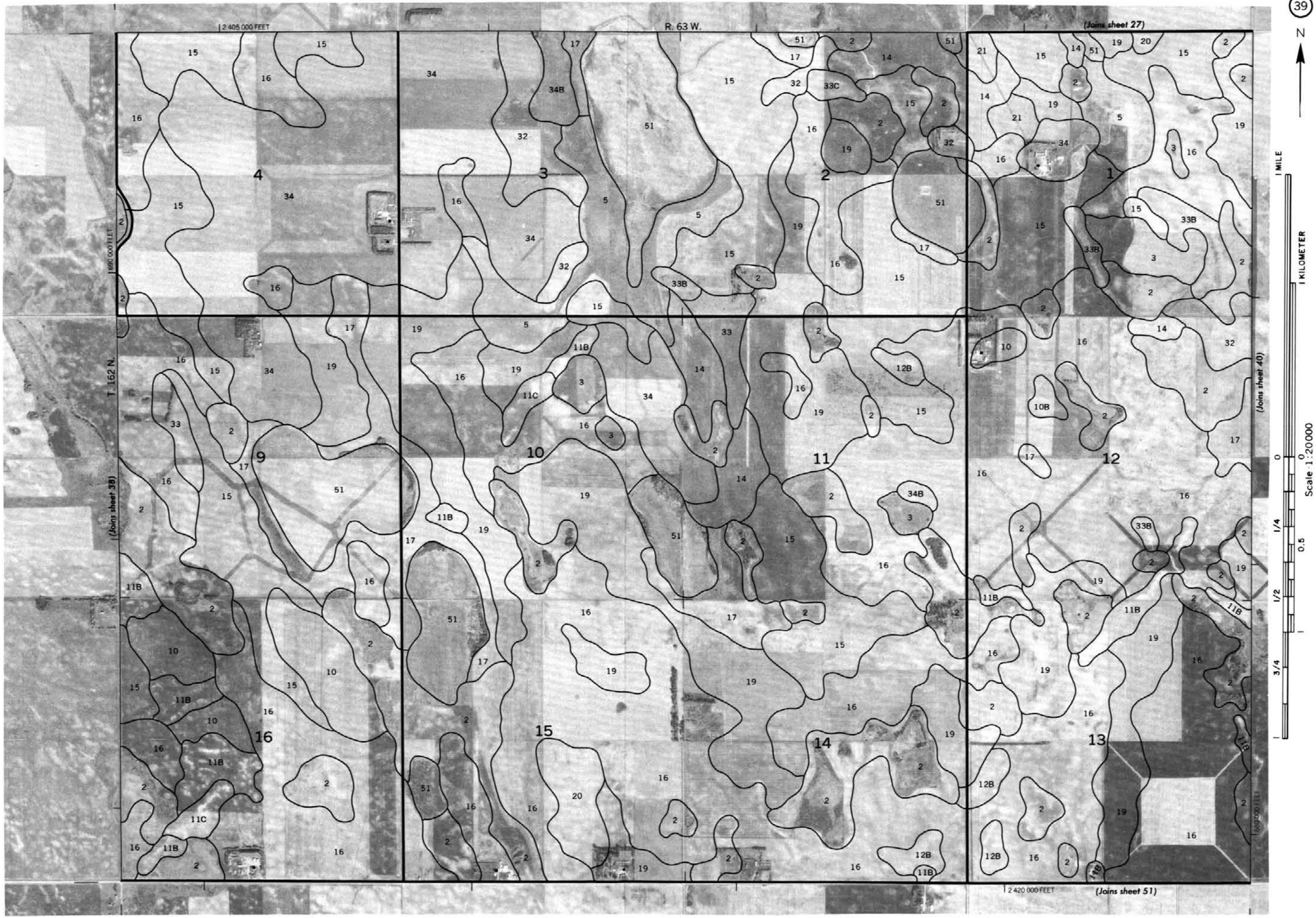

35
N
(Joins sheet 23)
(Joins sheet 34)
(Joins sheet 36)
(Joins sheet 47)
R. 58 W. | R. 57 W.
T. 163 N.
PEMBINA
RIVER
Norman Otto Hill
Old Baldy
Point Kneeshaw
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
2 575 000 FEET
710 000 FEET
700 000 FEET
2 590 000 FEET

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 36

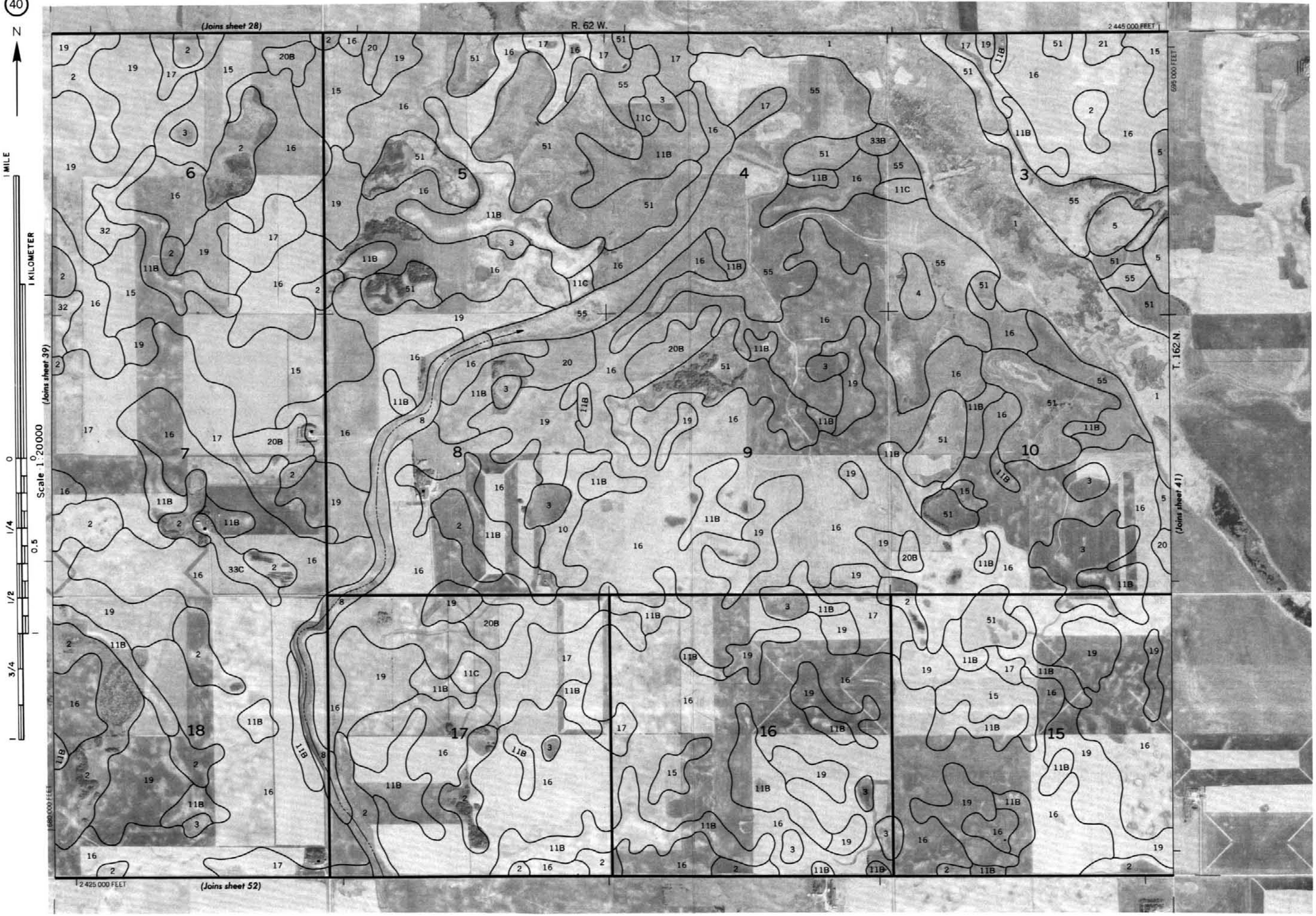


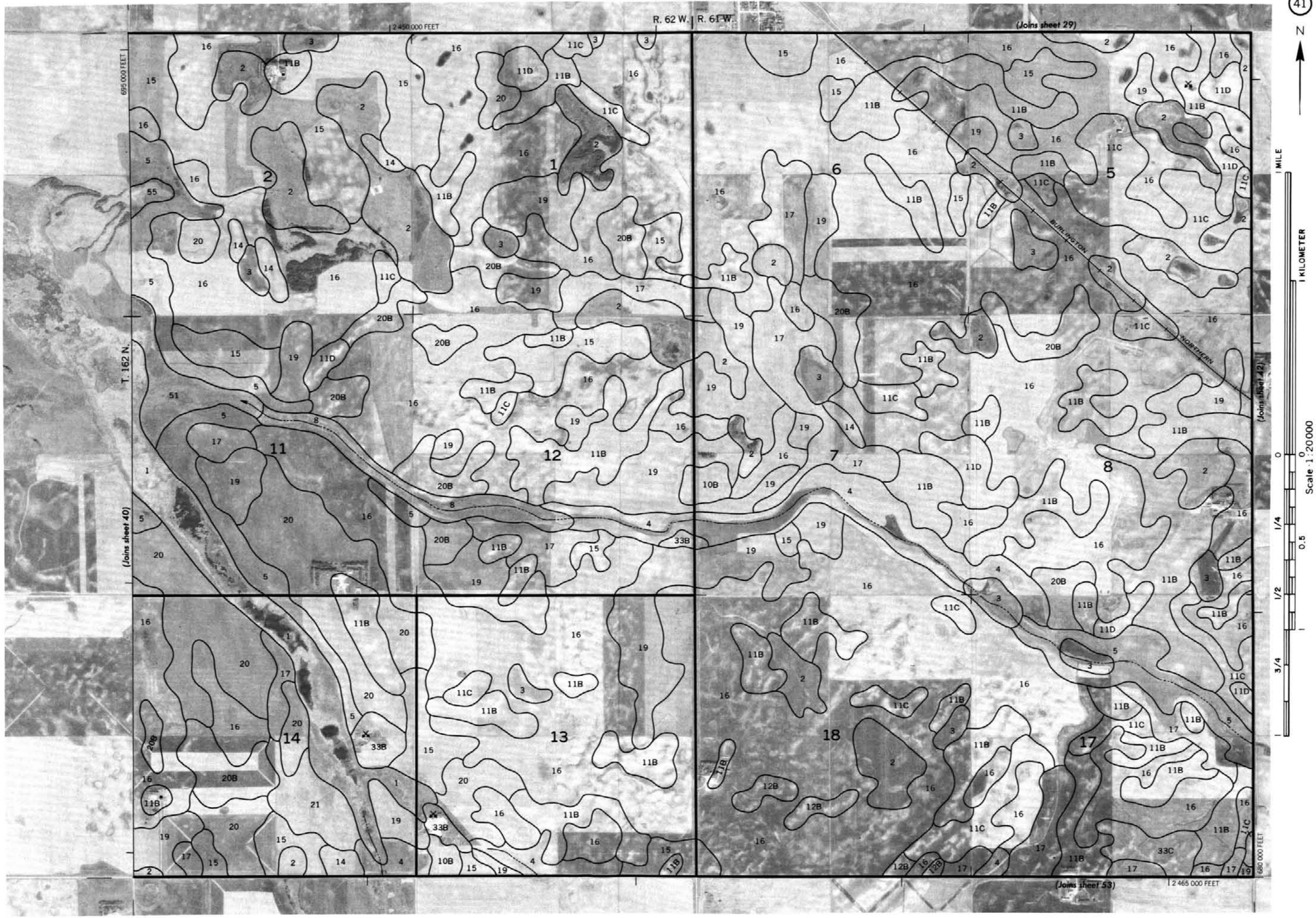

37
N
R. 64 W.
(Joins sheet 25)
(Joins sheet 38)
(Joins sheet 49)
2 365 000 FEET
690 000 FEET
2 380 000 FEET
T. 162 N.
TOWNER COUNTY
BURLINGTON NORTHERN
CORINTHIAN CEMETERY
Calvin
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


38
N
(Joins sheet 26)
R. 64 W. | R. 63 W.
2 400 000 FEET
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 50)
2 385 000 FEET
690 000 FEET
680 000 FEET
T. 162 N.
Cypress Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

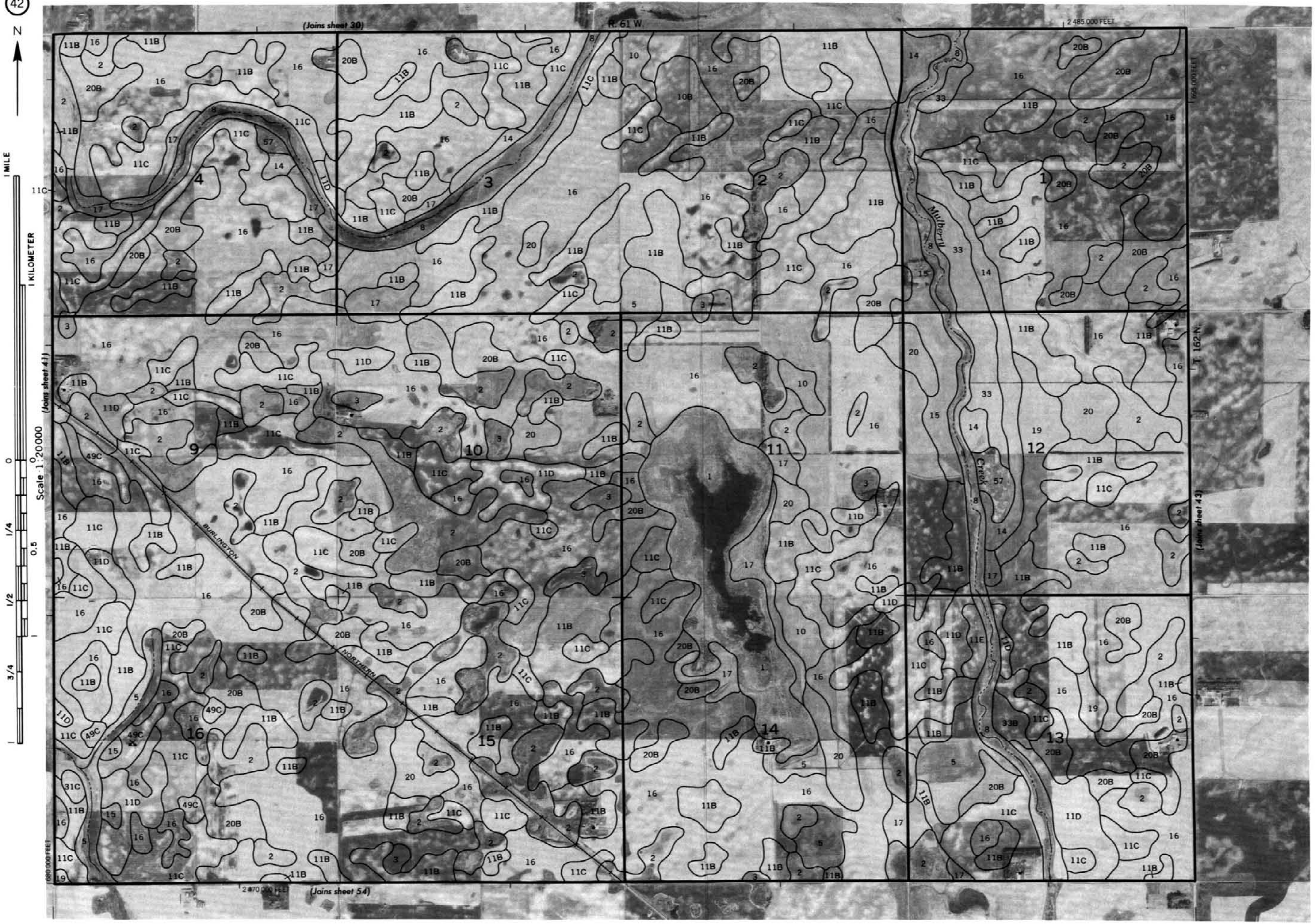

39
N
R. 63 W.
T. 162 N.
(Joins sheet 27)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 51)
2 405 000 FEET
2 420 000 FEET
690 000 FEET
660 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

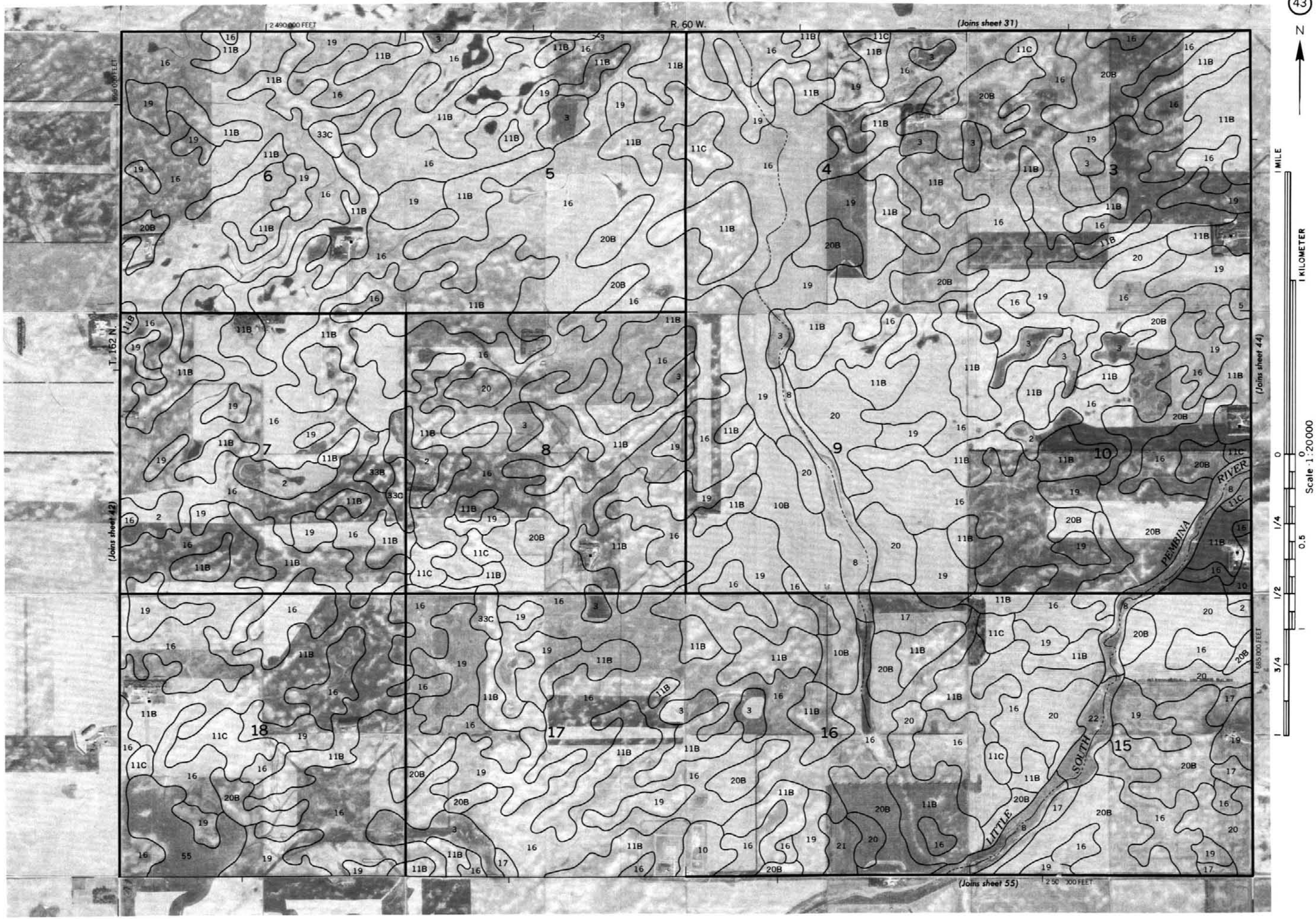
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 40

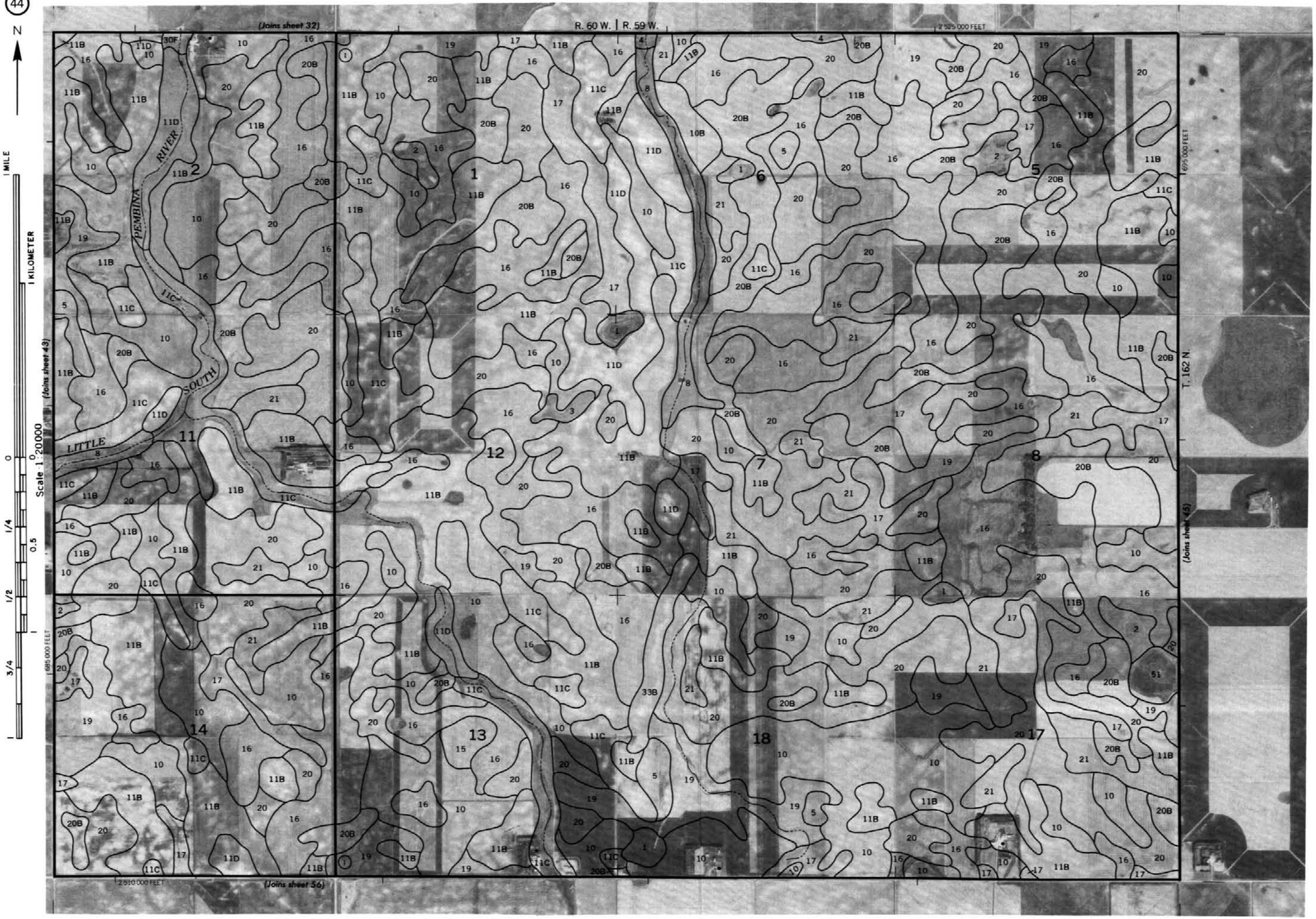


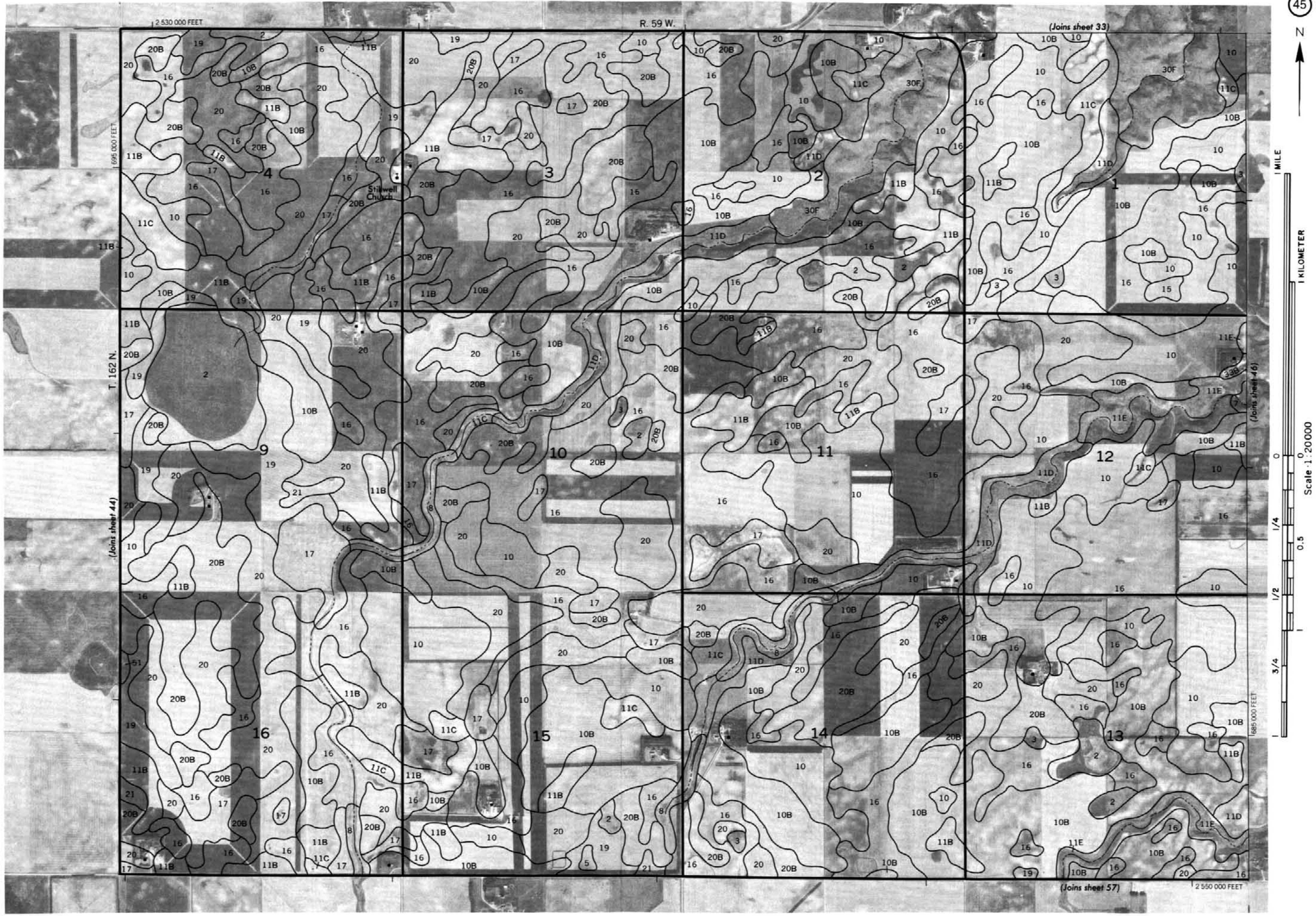

R. 62 W.
R. 61 W.
2 450 000 FEET
(Joins sheet 29)
695 000 FEET
T. 162 N.
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 53)
2 465 000 FEET
680 000 FEET
BURLINGTON
NORTHERN
N
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 42



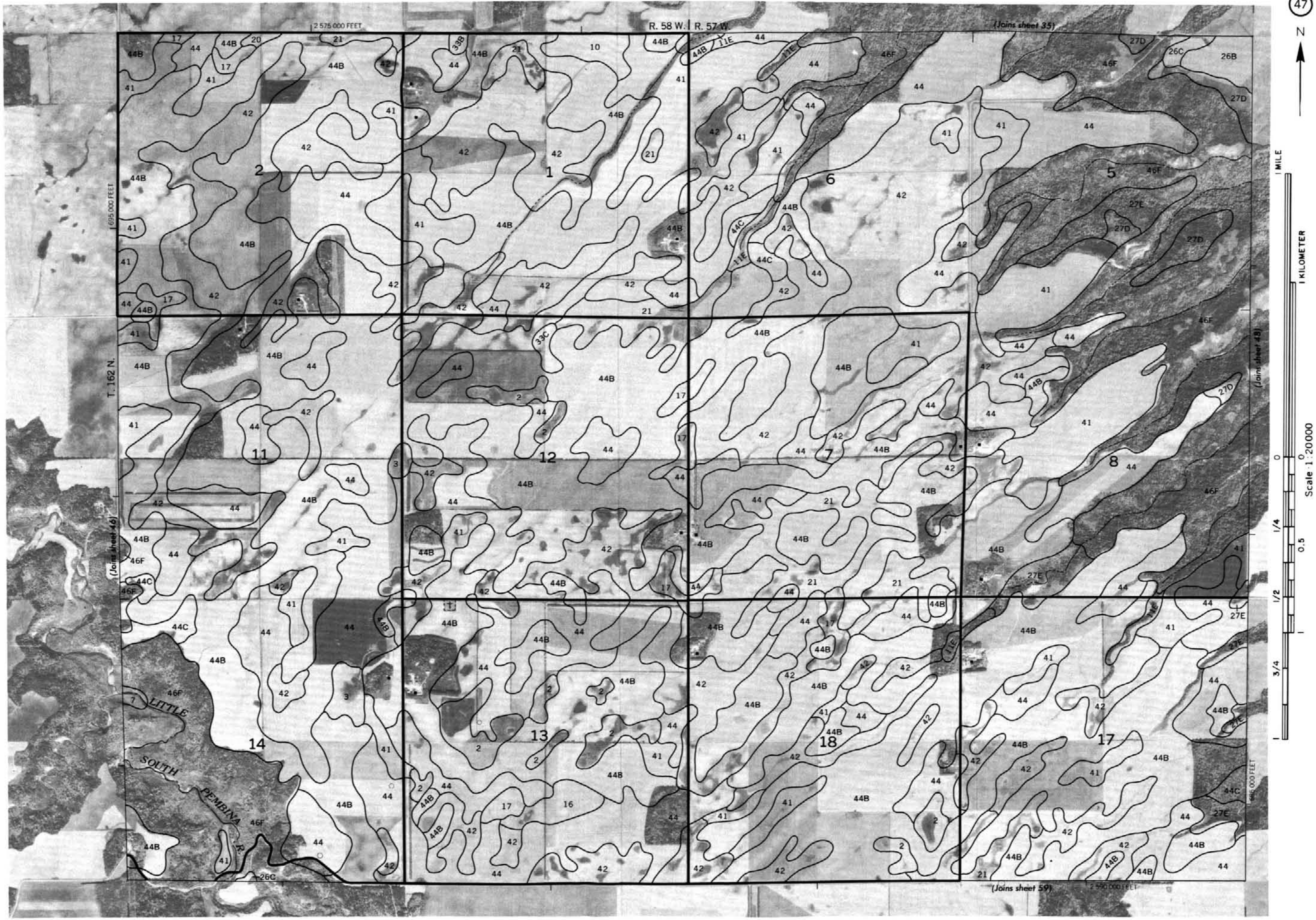

2 490 000 FEET
R. 60 W.
(Joins sheet 31)
N
T. 162 N.
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 55)
2 50 000 FEET
685 000 FEET
PEMBINA RIVER
LITTLE SOUTH
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

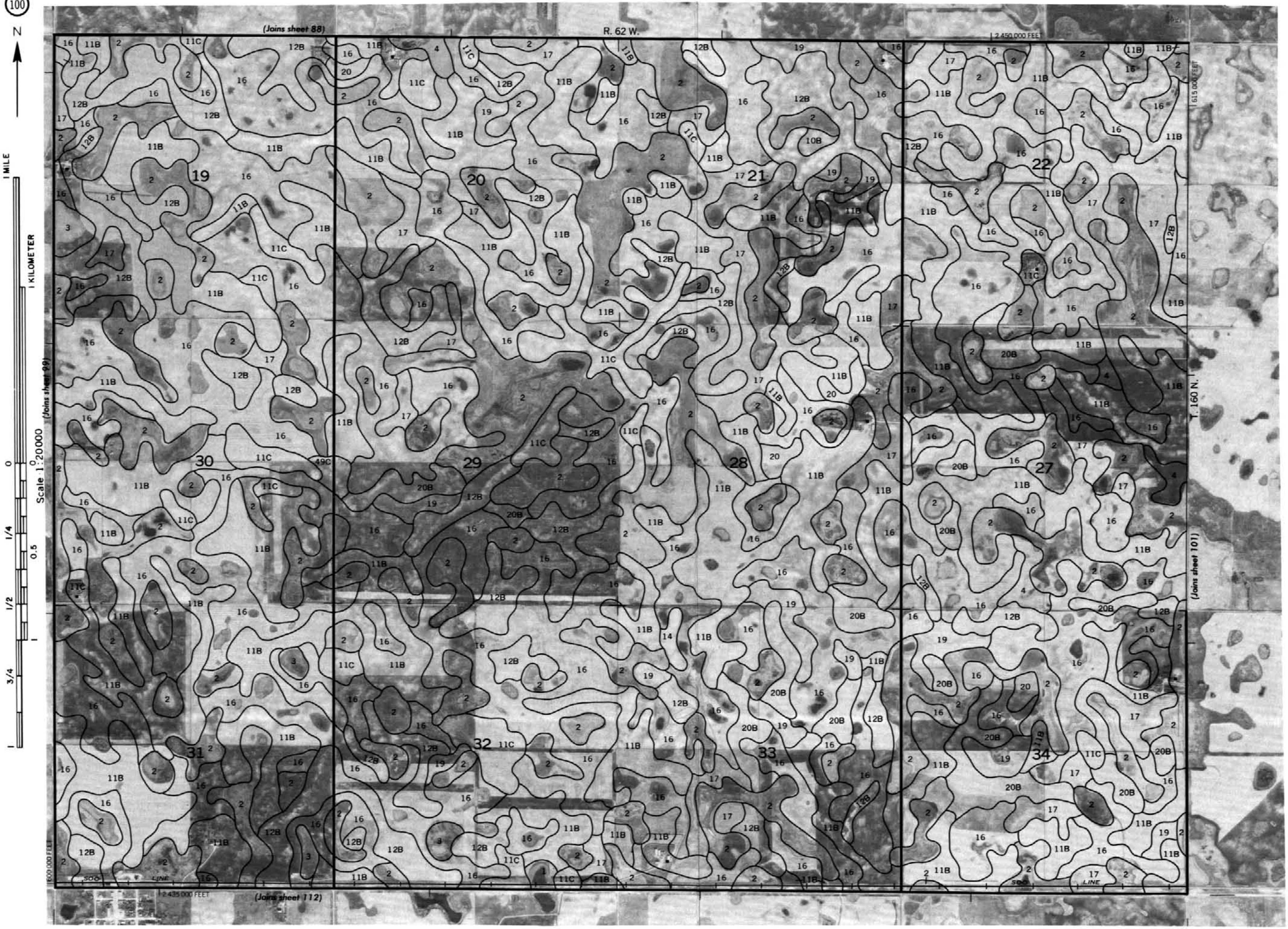

(Joins sheet 32)
R. 60 W. | R. 59 W.
2 525 000 FEET
695 000 FEET
T. 162 N.
(Joins sheet 45)
(Joins sheet 56)
2 510 000 FEET
685 000 FEET
(Joins sheet 43)
PEMBINA RIVER
SOUTH
LITTLE
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

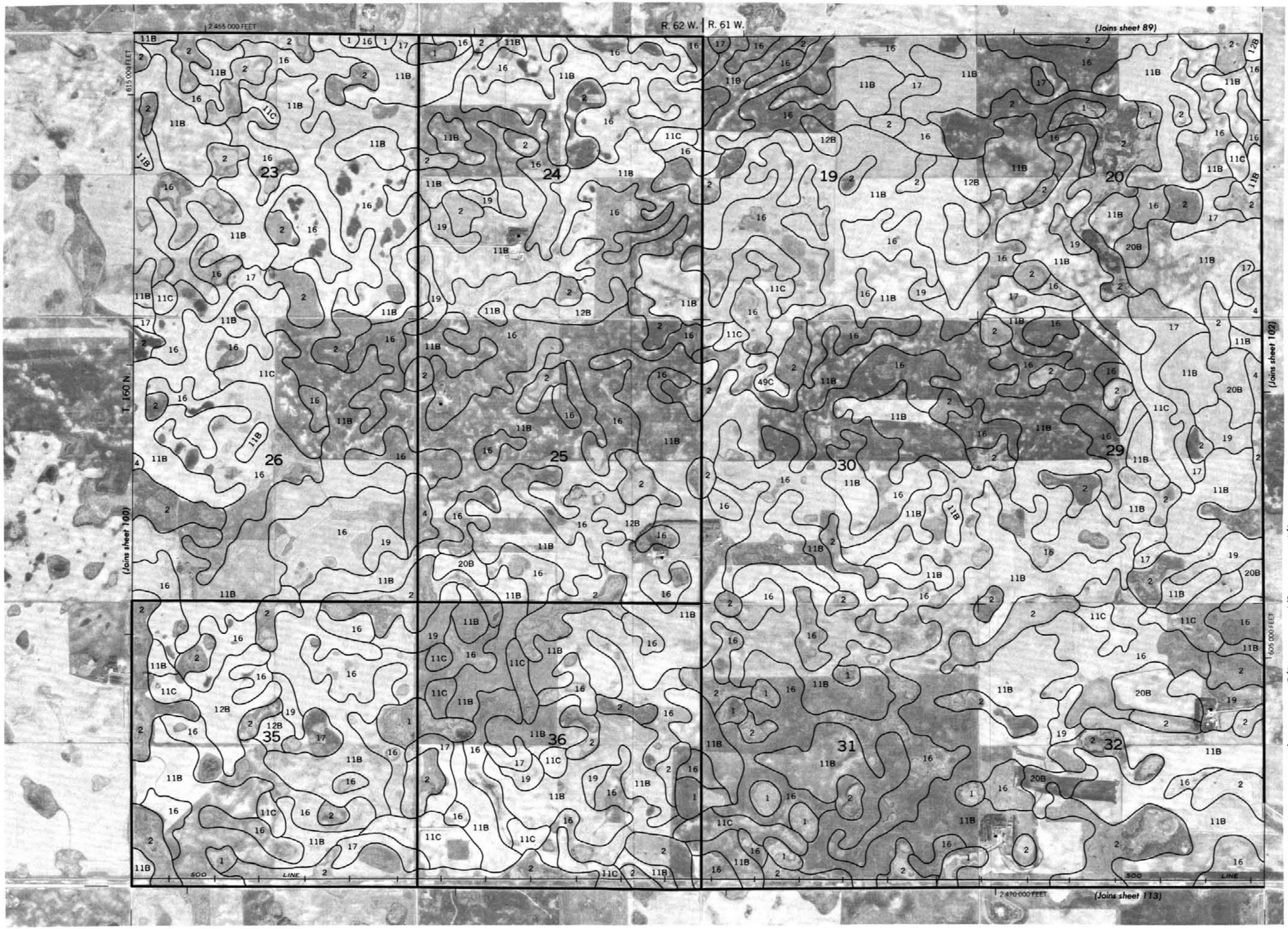

2 530 000 FEET
R. 59 W.
(Joins sheet 33)
695 000 FEET
Stillwell Church
T. 162 N.
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 57)
685 000 FEET
2 550 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 46

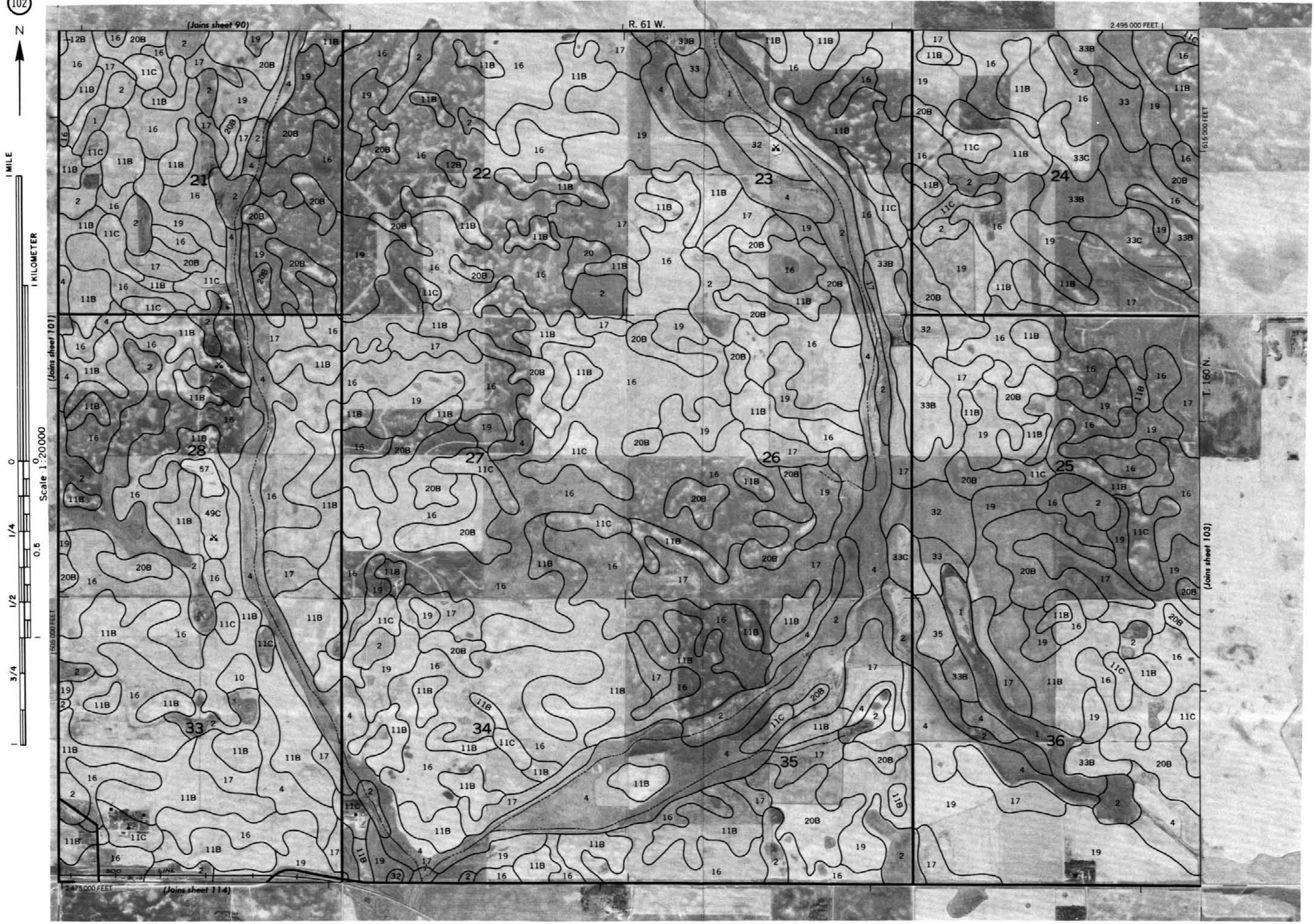
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 47



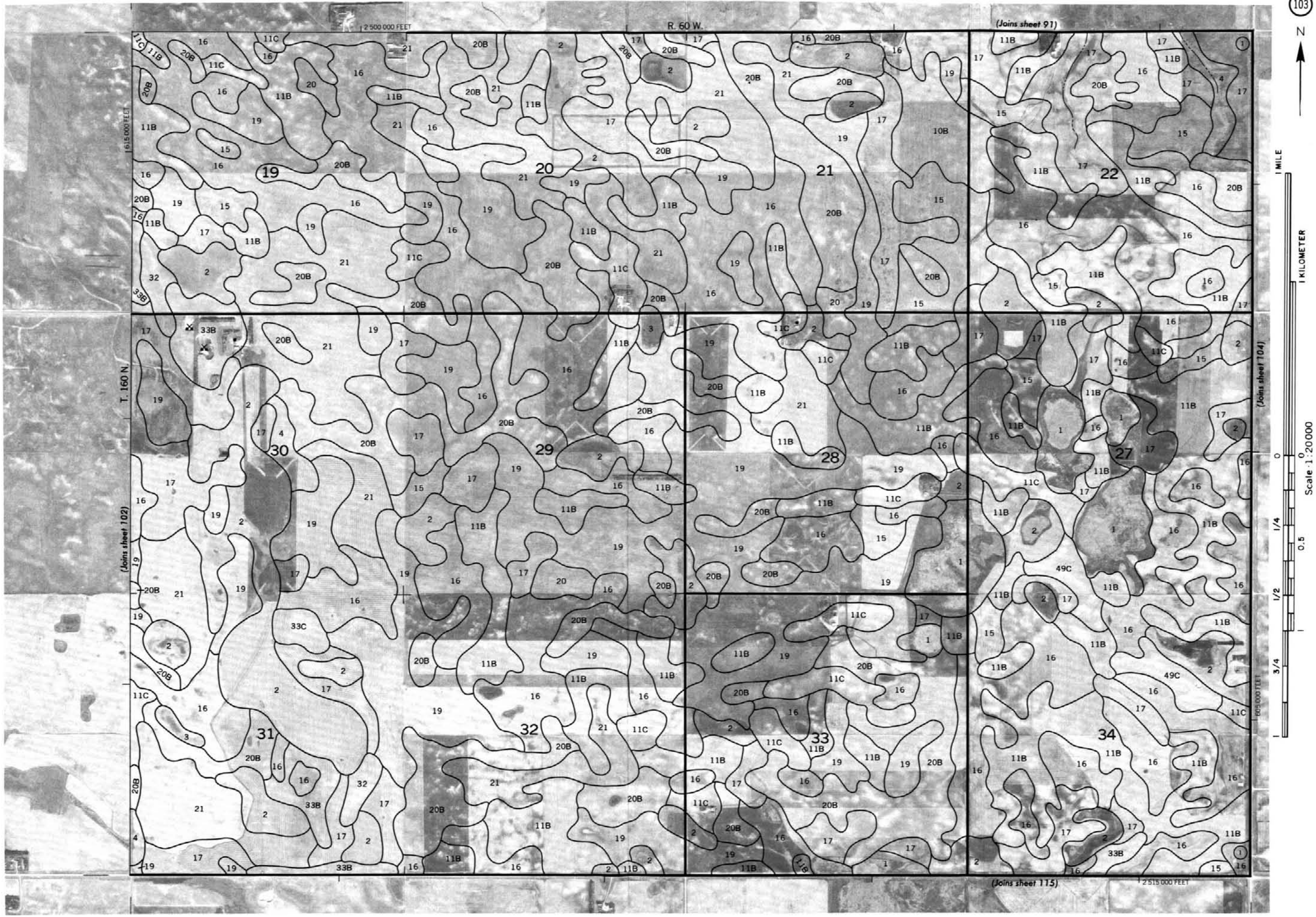

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 88)
R. 62 W.
2 450 000 FEET
615 000 FEET
(Joins sheet 99)
(Joins sheet 101)
T. 160 N.
(Joins sheet 112)
2 435 000 FEET
600 000 FEET
SOO LINE
19
20
21
22
27
28
29
30
31
32
33
34


101
N
R. 62 W.
R. 61 W.
(Joins sheet 89)
(Joins sheet 102)
(Joins sheet 113)
(Joins sheet 100)
T. 160 N.
2 455 000 FEET
2 470 000 FEET
615 000 FEET
605 000 FEET
500 LINE
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
23
24
19
20
26
25
30
29
35
36
31
32

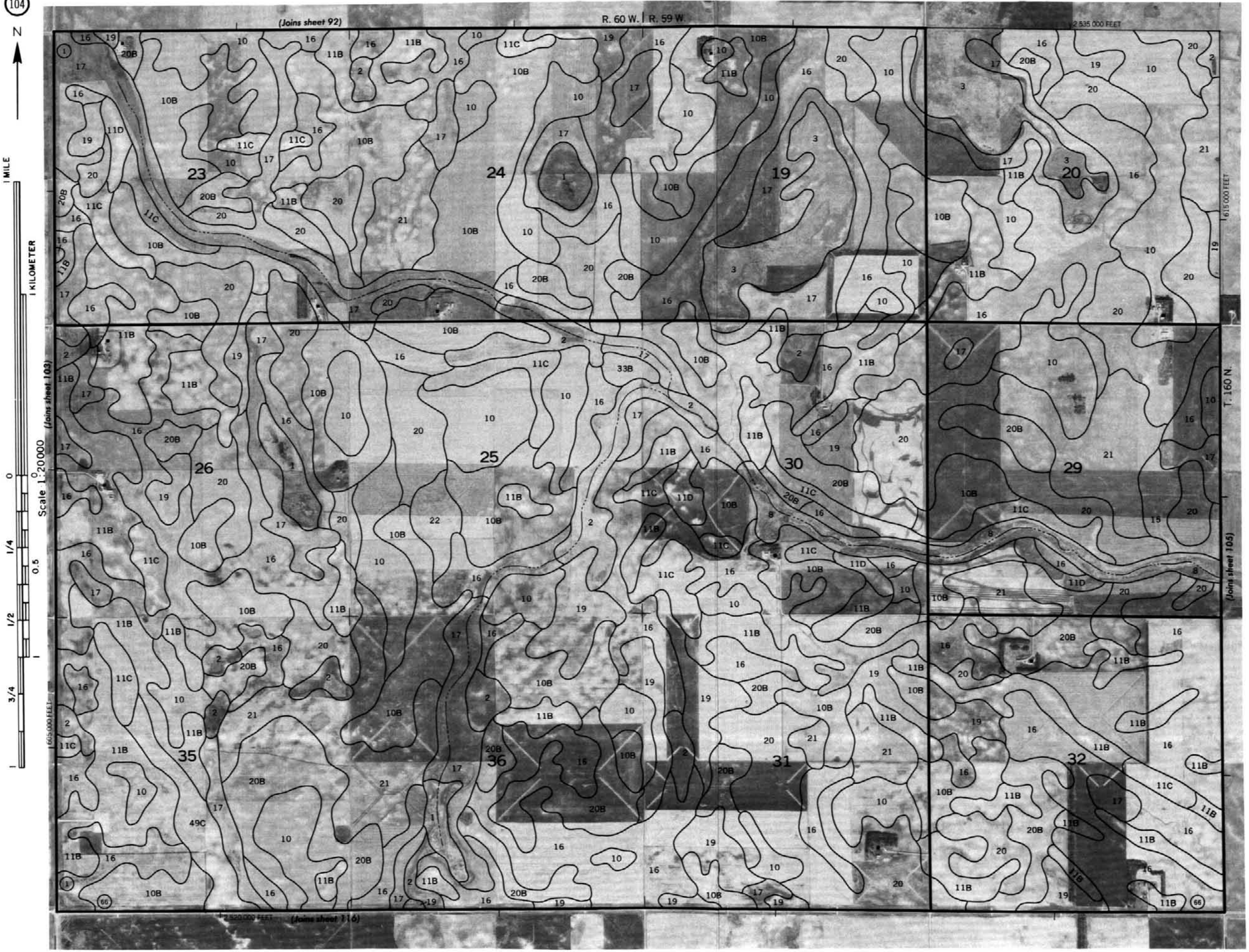
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 102

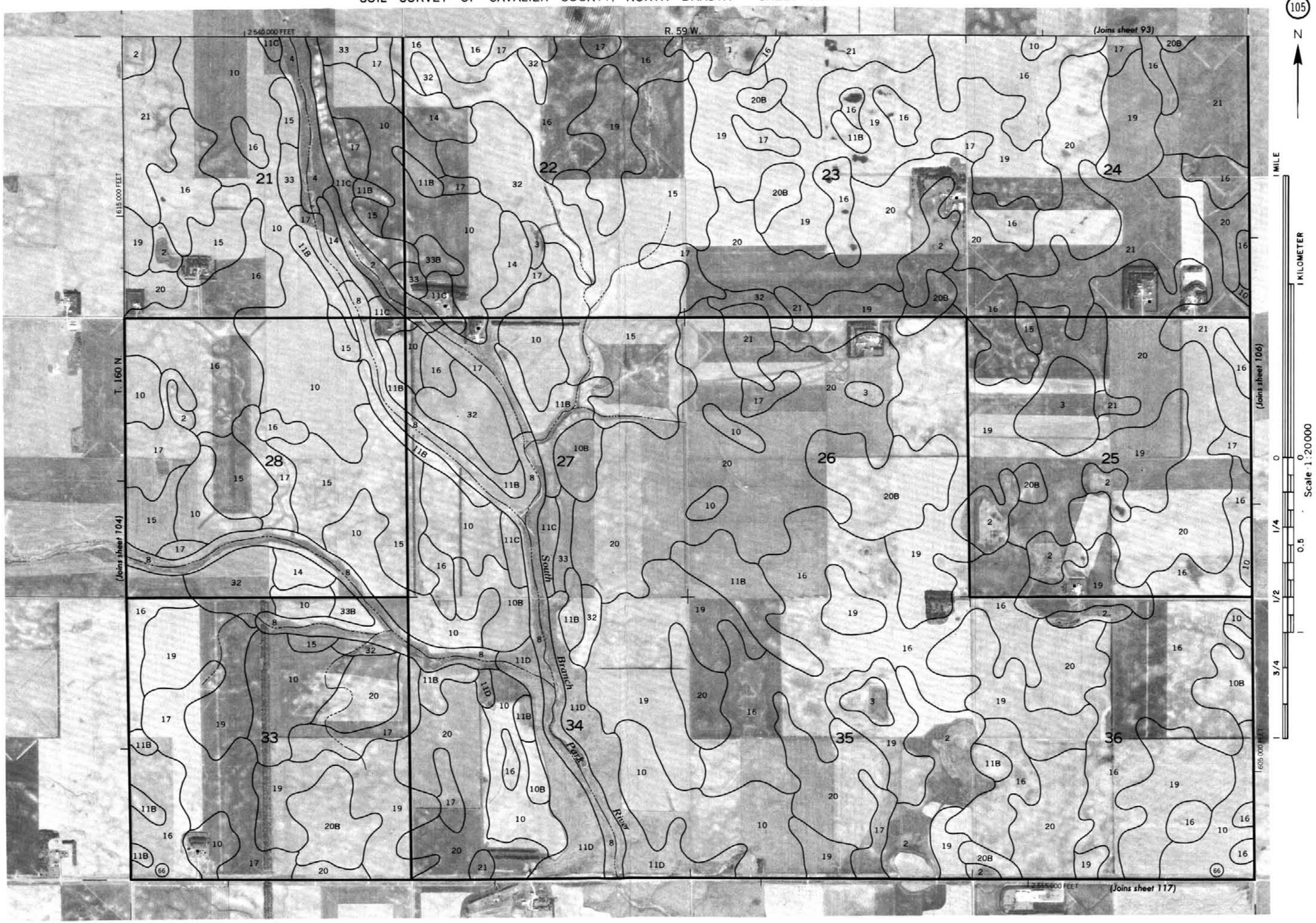


SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 103

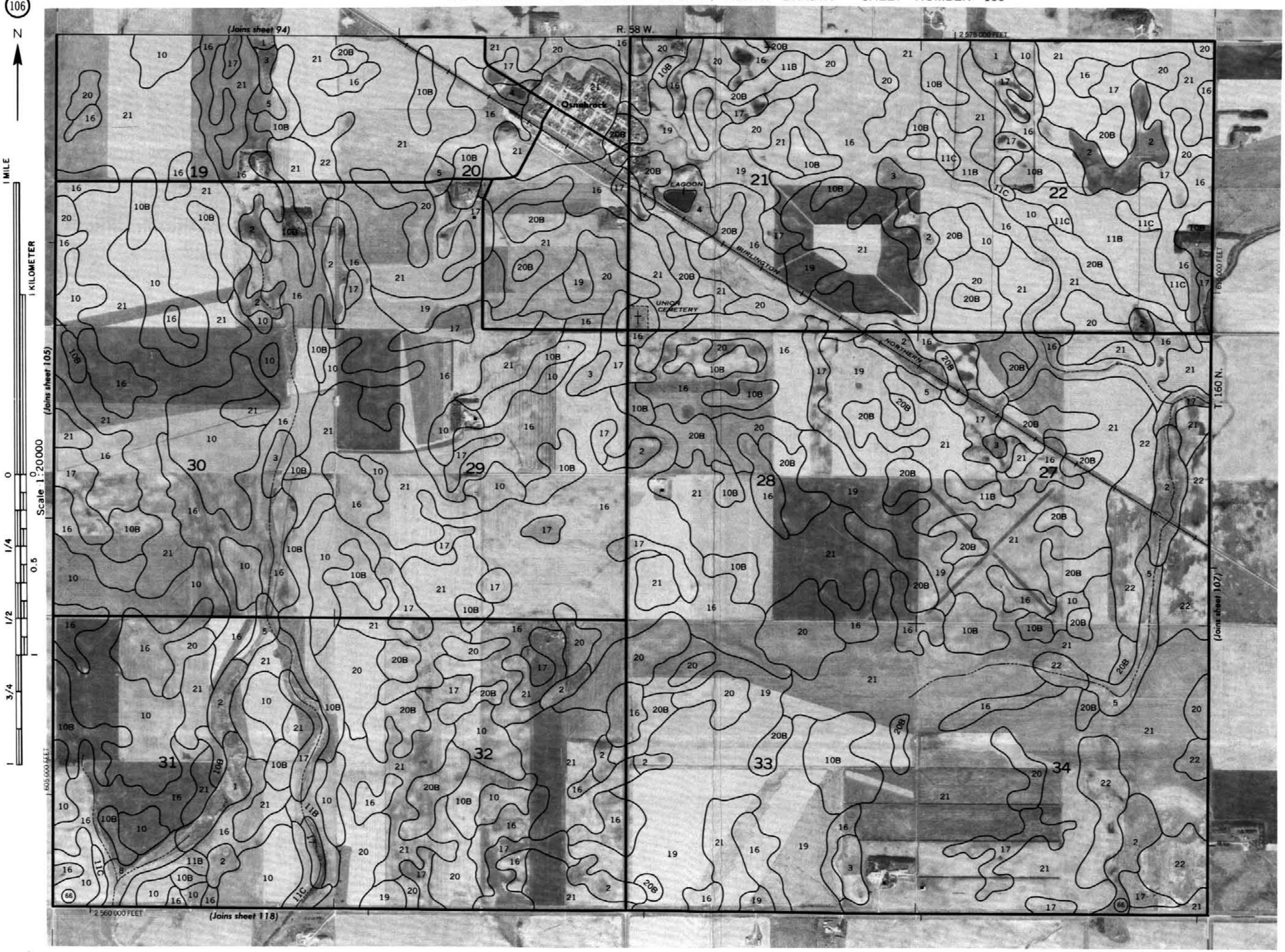


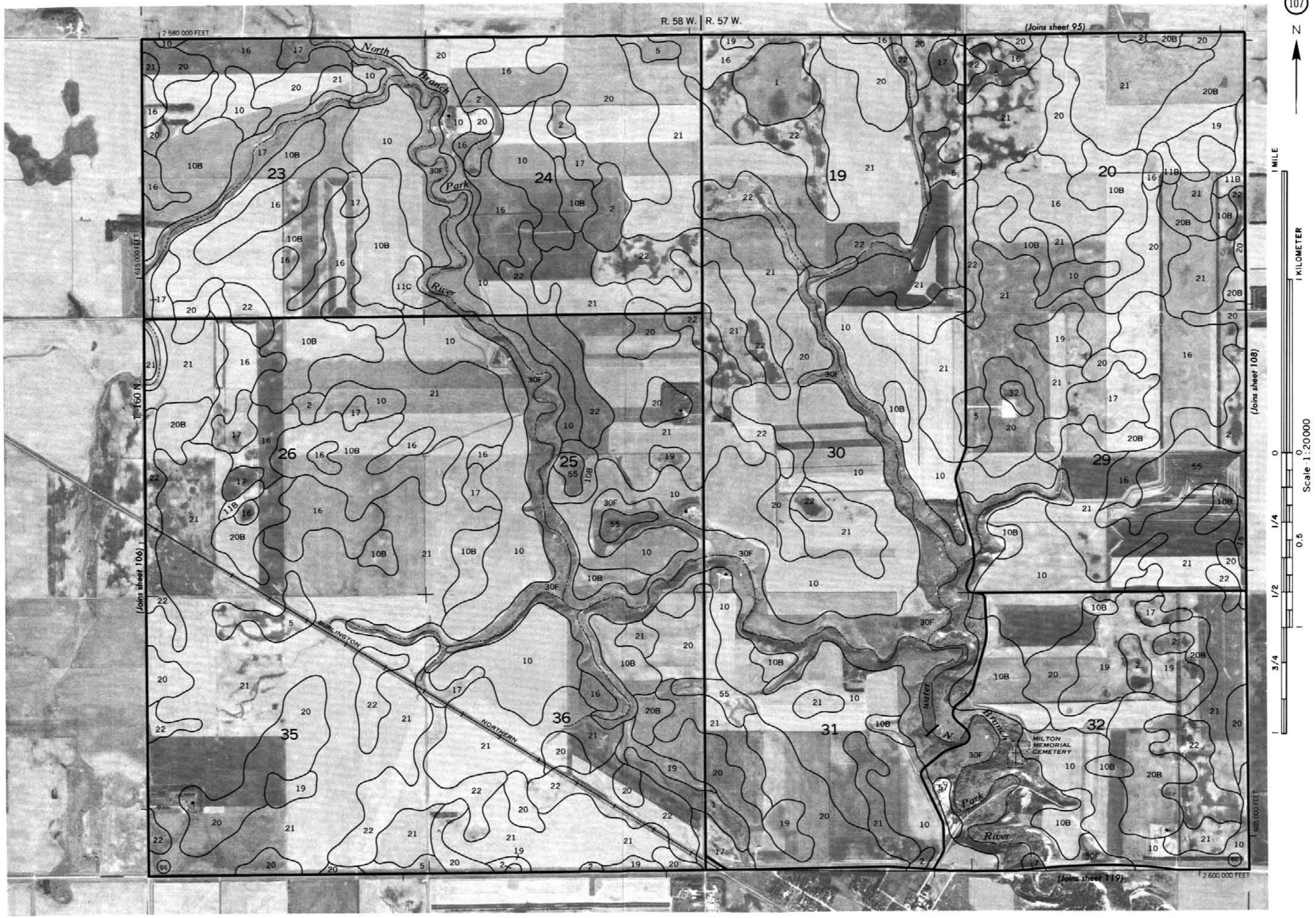
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 104



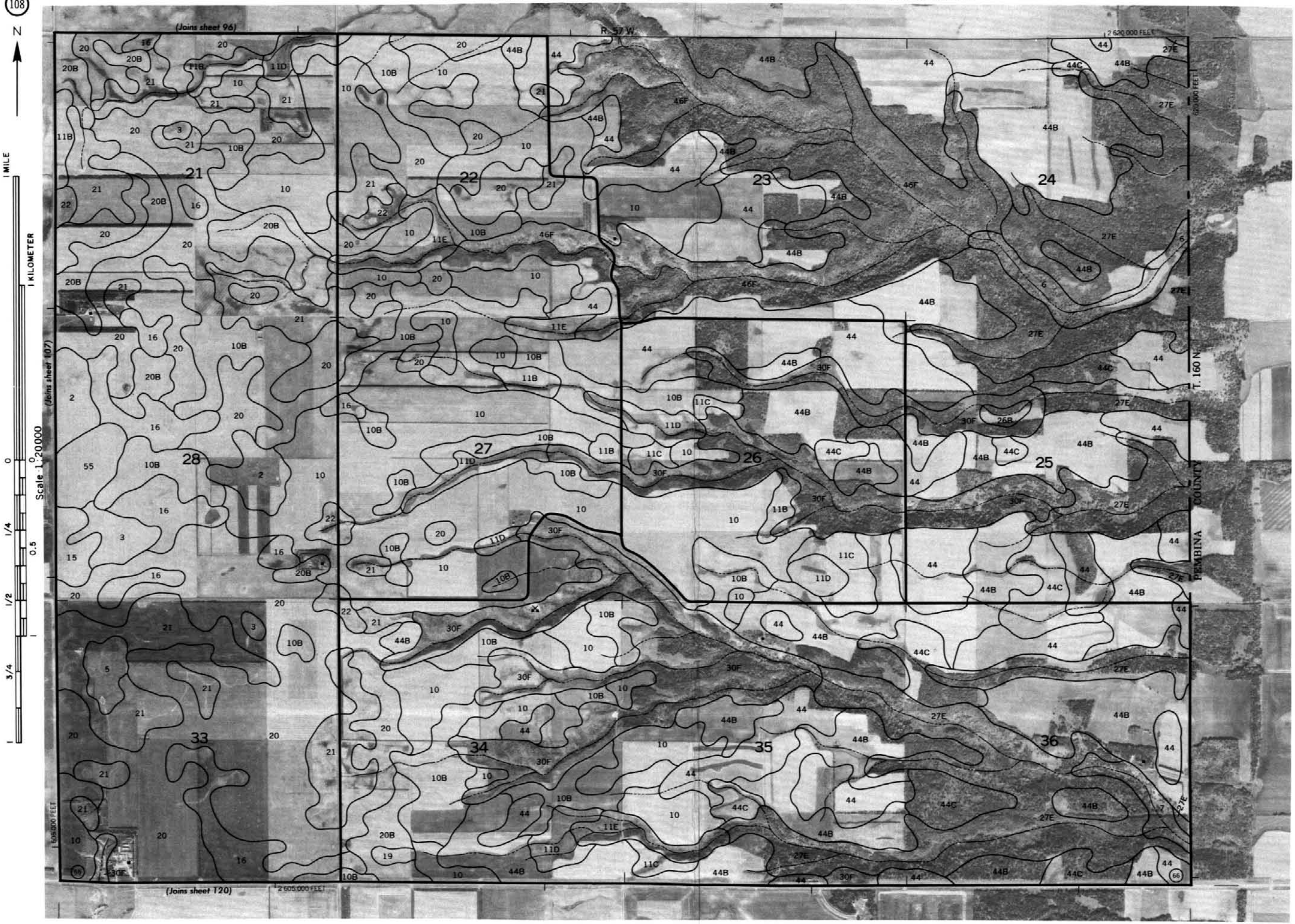

105
N
R. 59 W.
(Joins sheet 93)
2 540 000 FEET
615 000 FEET
T. 160 N.
(Joins sheet 104)
(Joins sheet 106)
(Joins sheet 117)
2 555 000 FEET
605 000 FEET
South Branch Park River
21
22
23
24
28
27
26
25
33
34
35
36
66
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

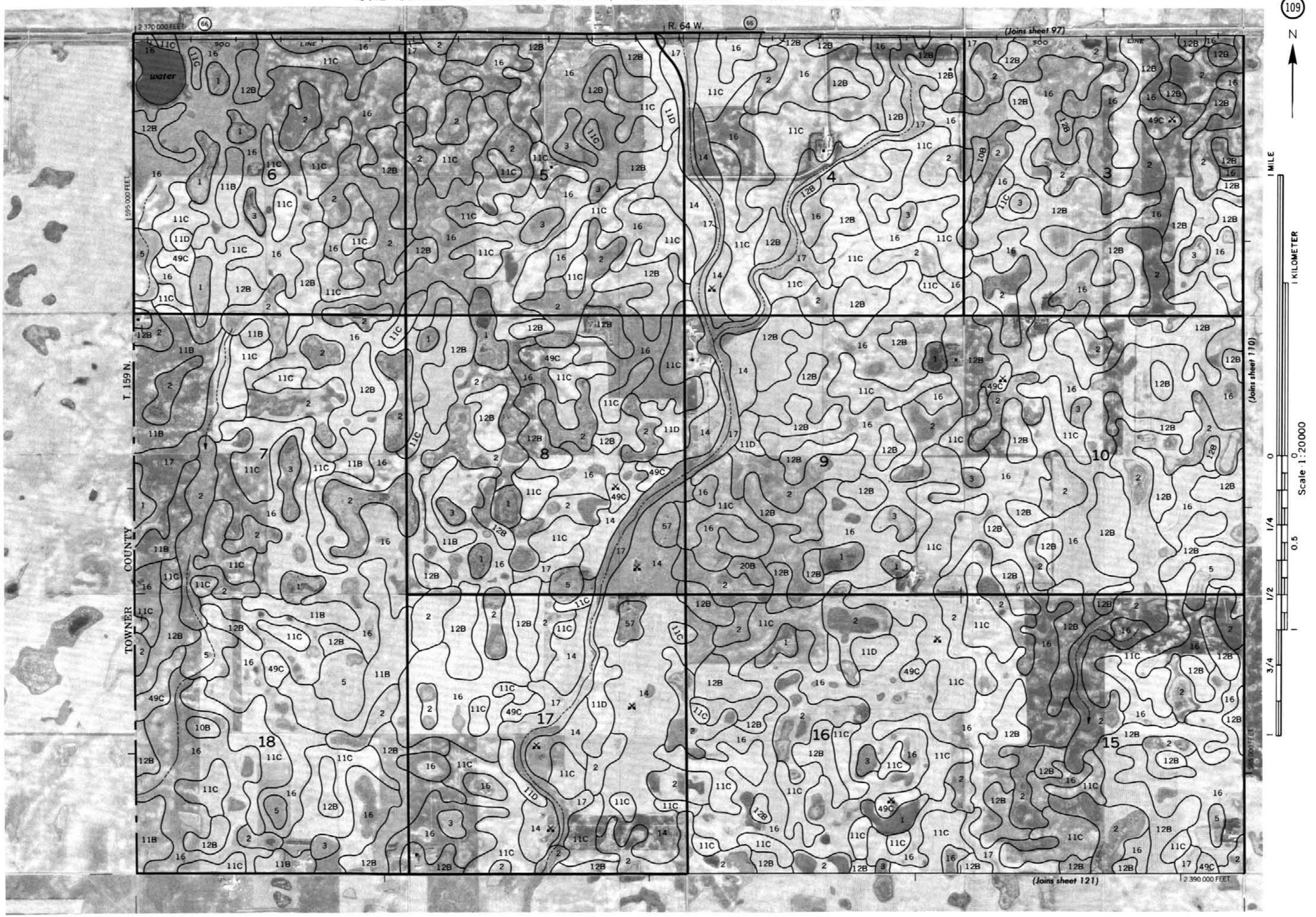
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 106

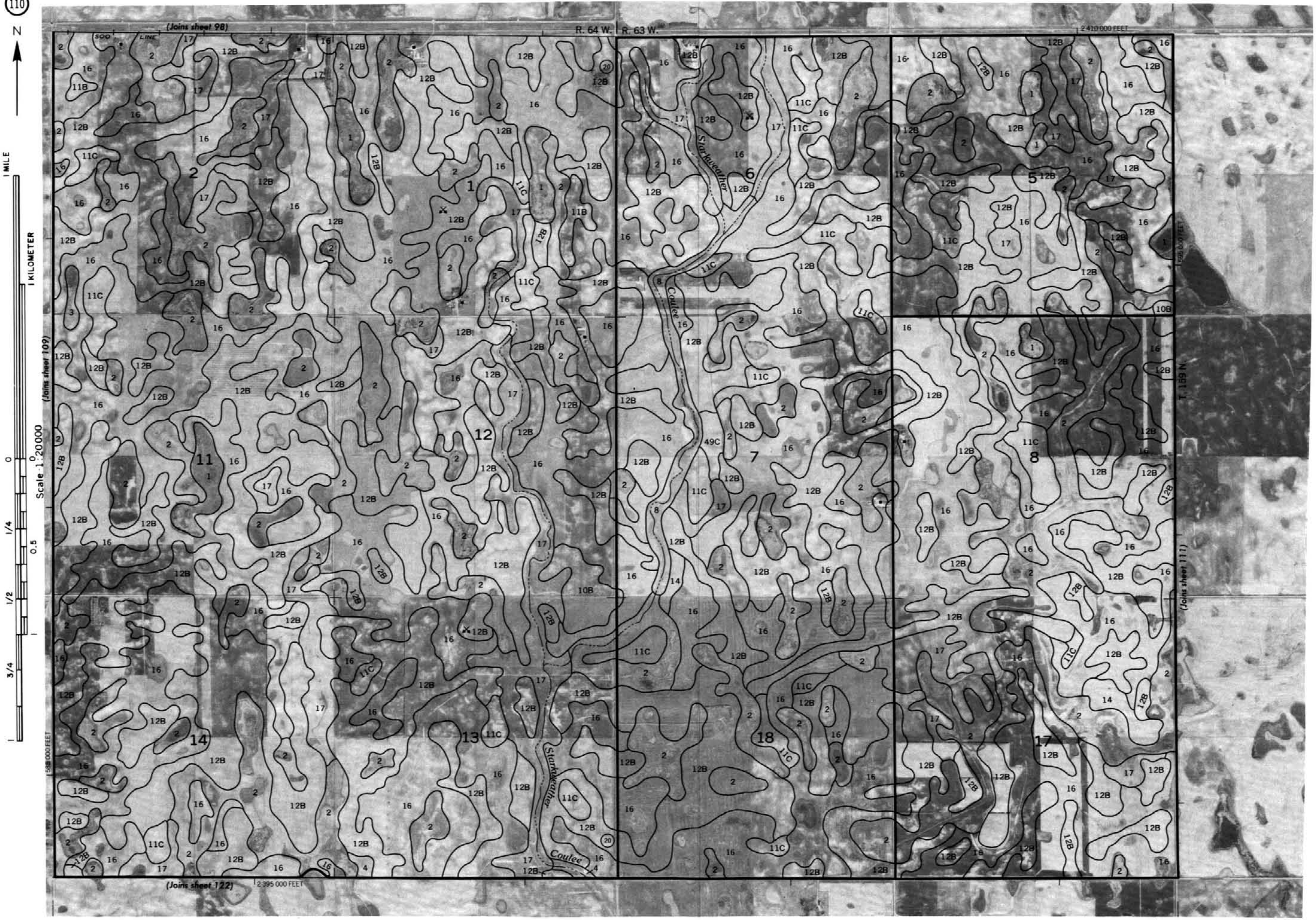


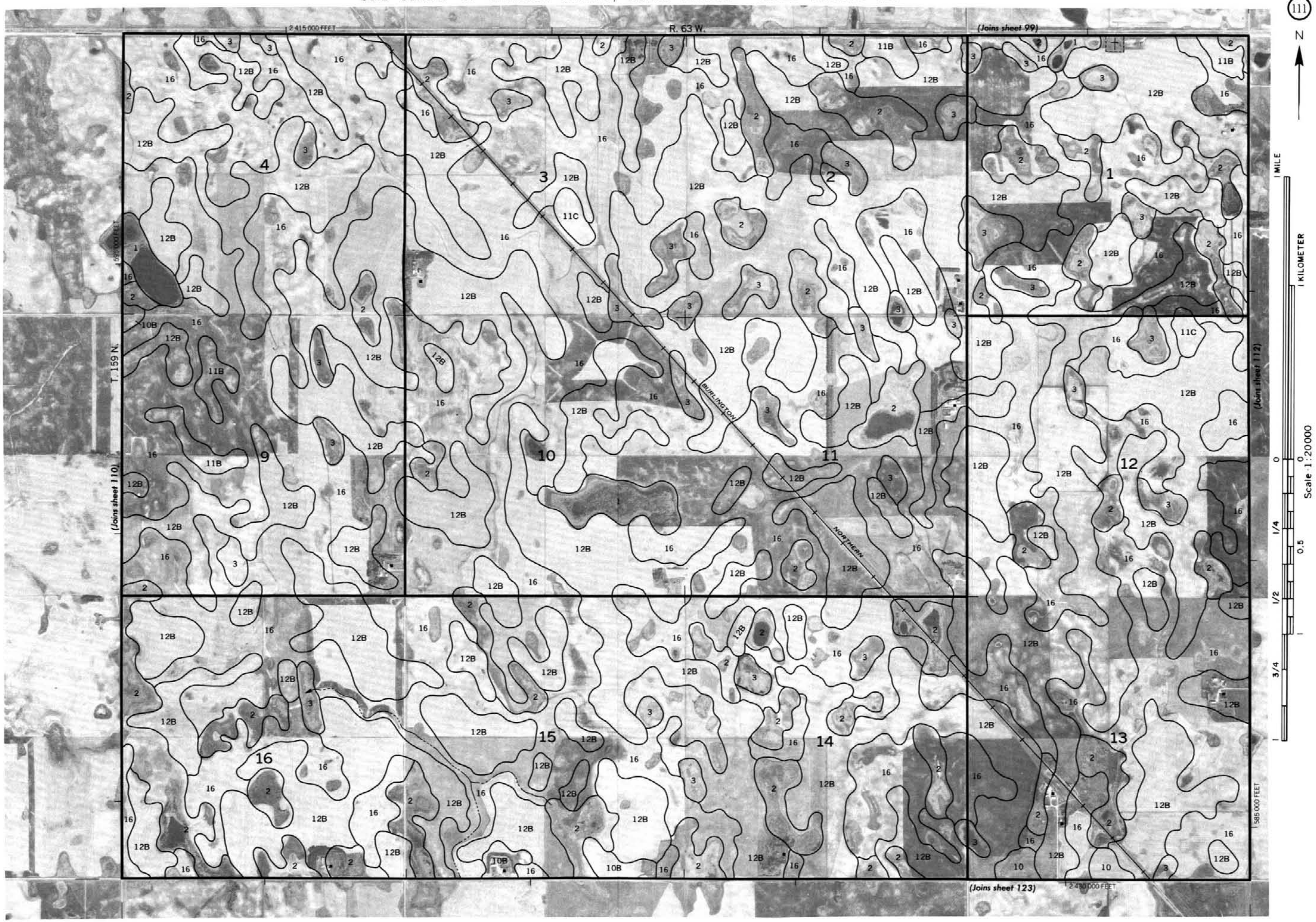

R. 58 W. | R. 57 W.
(Joins sheet 95)
(Joins sheet 106)
(Joins sheet 108)
(Joins sheet 119)
T. 160 N.
2 580 000 FEET
2 600 000 FEET
615 000 FEET
605 000 FEET
North Branch Park River
BURLINGTON NORTHERN
MILTON MEMORIAL CEMETERY
23
24
19
20
26
25
30
29
35
36
31
32
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

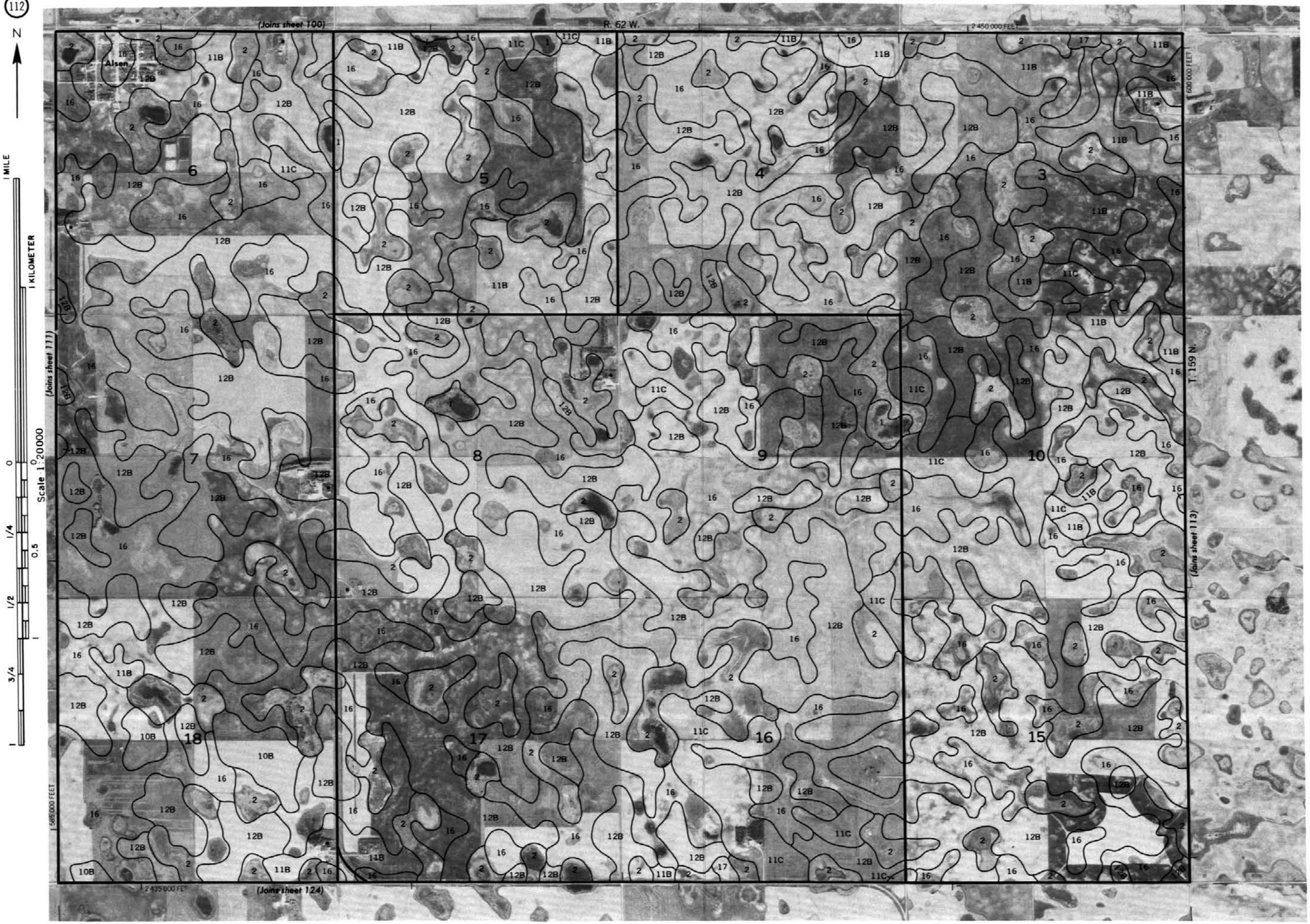
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 108

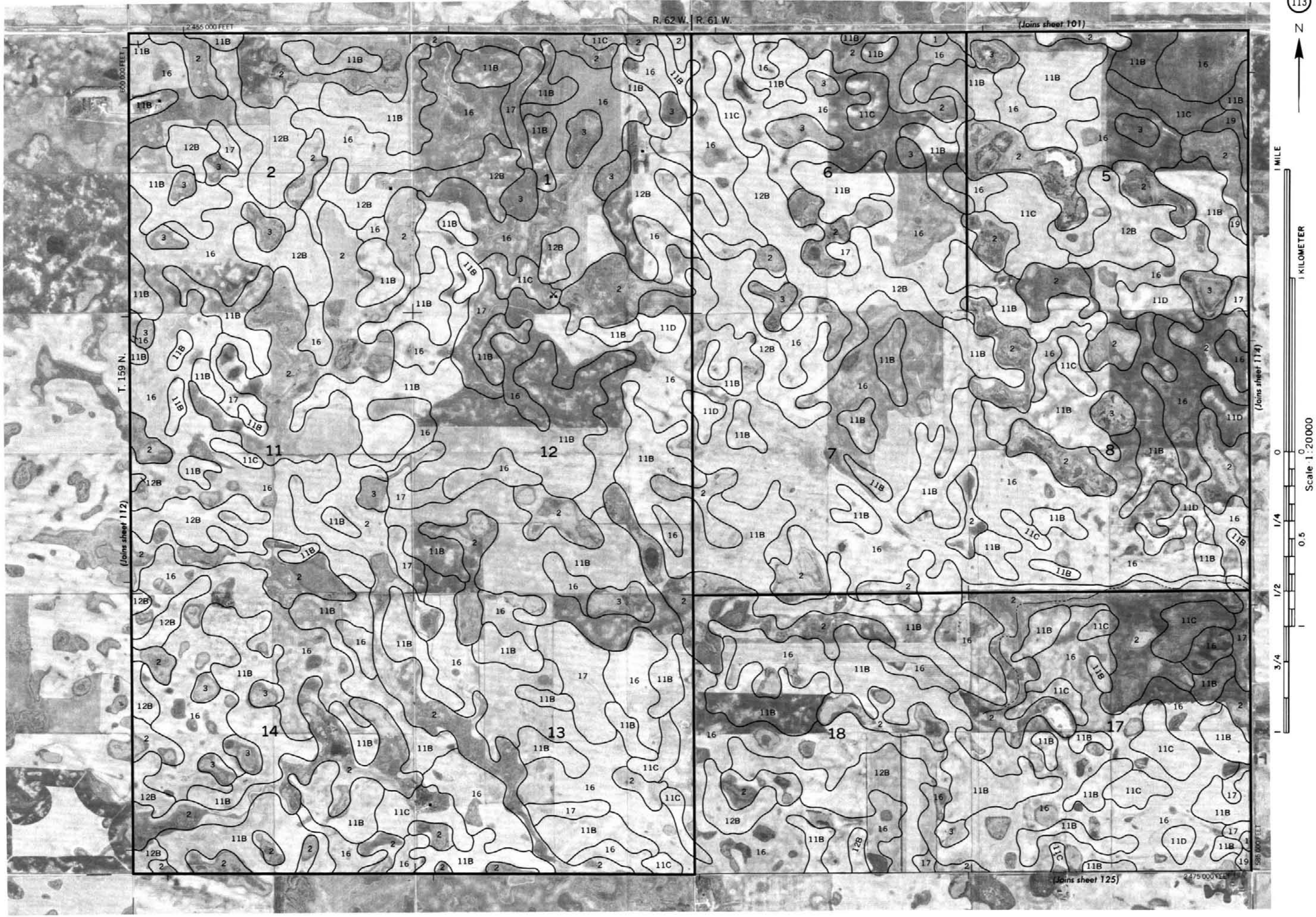


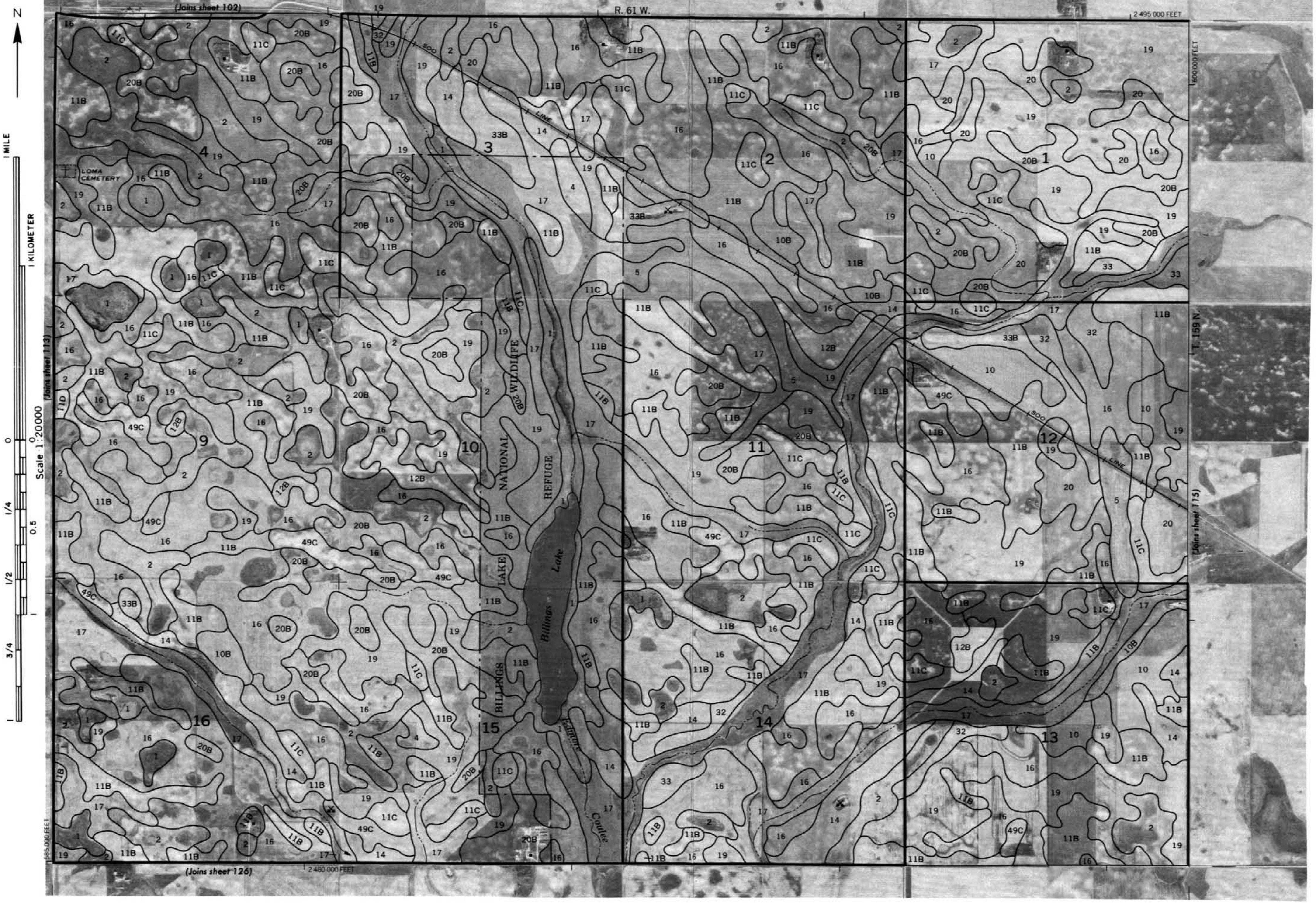

109
N
R. 64 W.
(Joins sheet 97)
(Joins sheet 110)
(Joins sheet 121)
T. 159 N.
TOWNER COUNTY
2 370 000 FEET
2 390 000 FEET
595 000 FEET
SOO LINE
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
(Joins sheet 98)
SOO LINE
R. 64 W.
R. 63 W.
2 410 000 FEET
T. 159 N.
(Joins sheet 111)
(Joins sheet 109)
(Joins sheet 122)
2 395 000 FEET
Starkweather
Coulee
Starkweather
Coulee
1
2
5
6
7
8
11
12
13
14
17
18

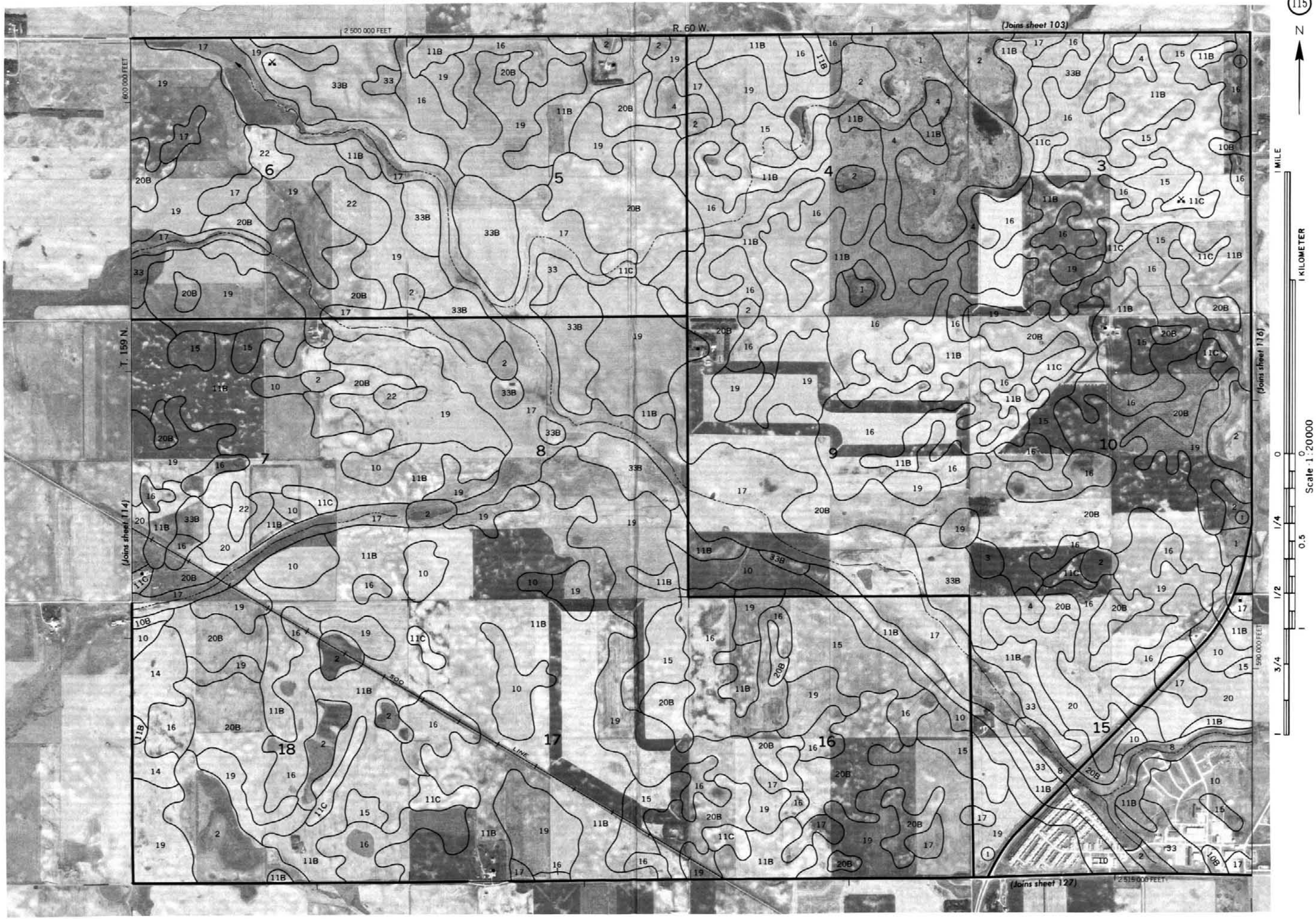

111
N
2 415 000 FEET
R. 63 W.
(Joins sheet 99)
T. 159 N.
(Joins sheet 110)
(Joins sheet 112)
(Joins sheet 123)
2 430 000 FEET
595 000 FEET
585 000 FEET
BURLINGTON
NORTHERN
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
1
2
3
4
9
10
11
12
13
14
15
16

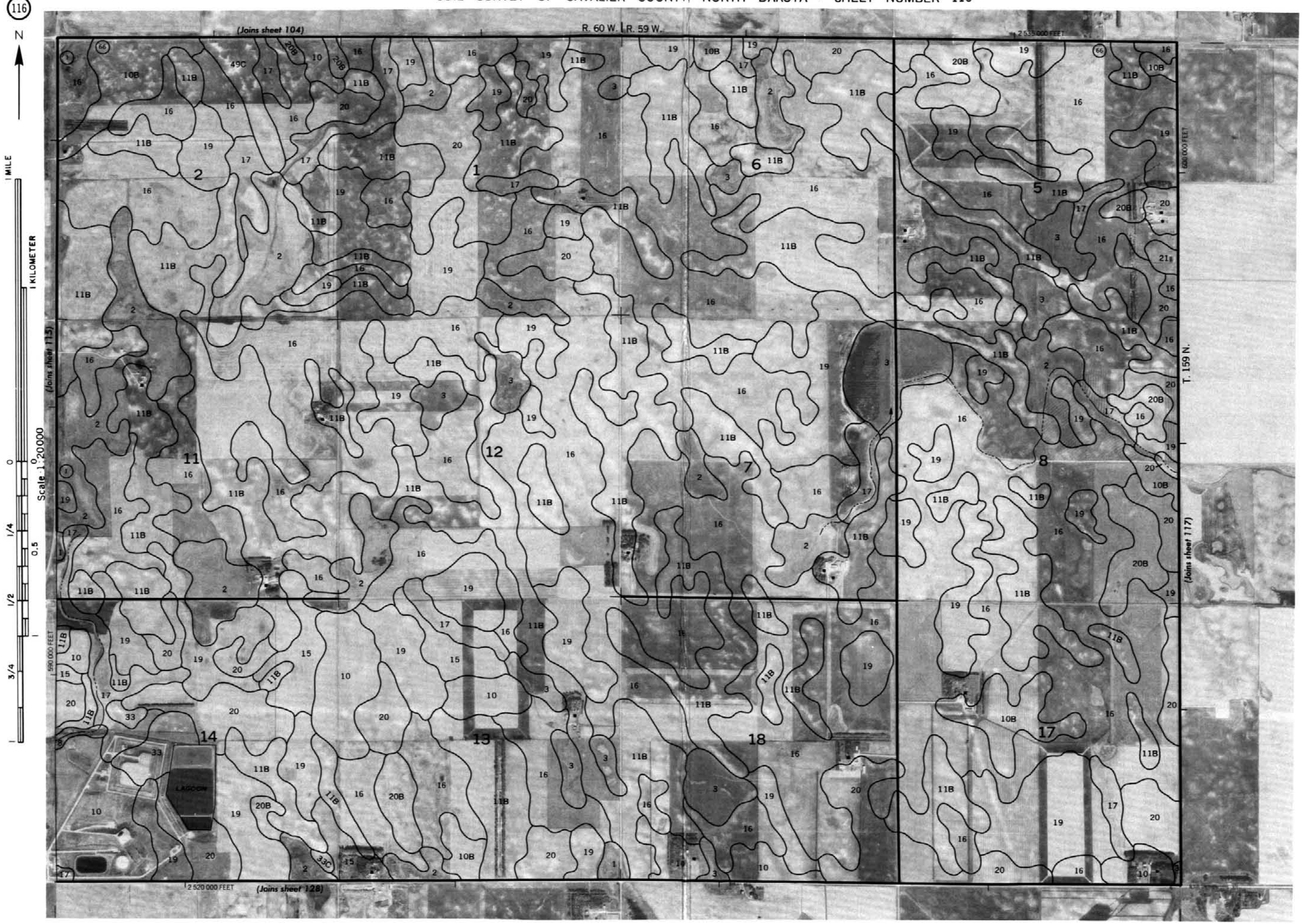

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 100)
R. 62 W.
2 450 000 FEET
600 000 FEET
T. 159 N.
(Joins sheet 113)
(Joins sheet 111)
(Joins sheet 124)
2 435 000 FEET
585 000 FEET
Alsen
6
5
4
3
7
8
9
10
18
17
16
15


113
N
R. 62 W. | R. 61 W.
(Joins sheet 101)
(Joins sheet 112)
(Joins sheet 114)
(Joins sheet 125)
T. 159 N.
2 455 000 FEET
2 475 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000

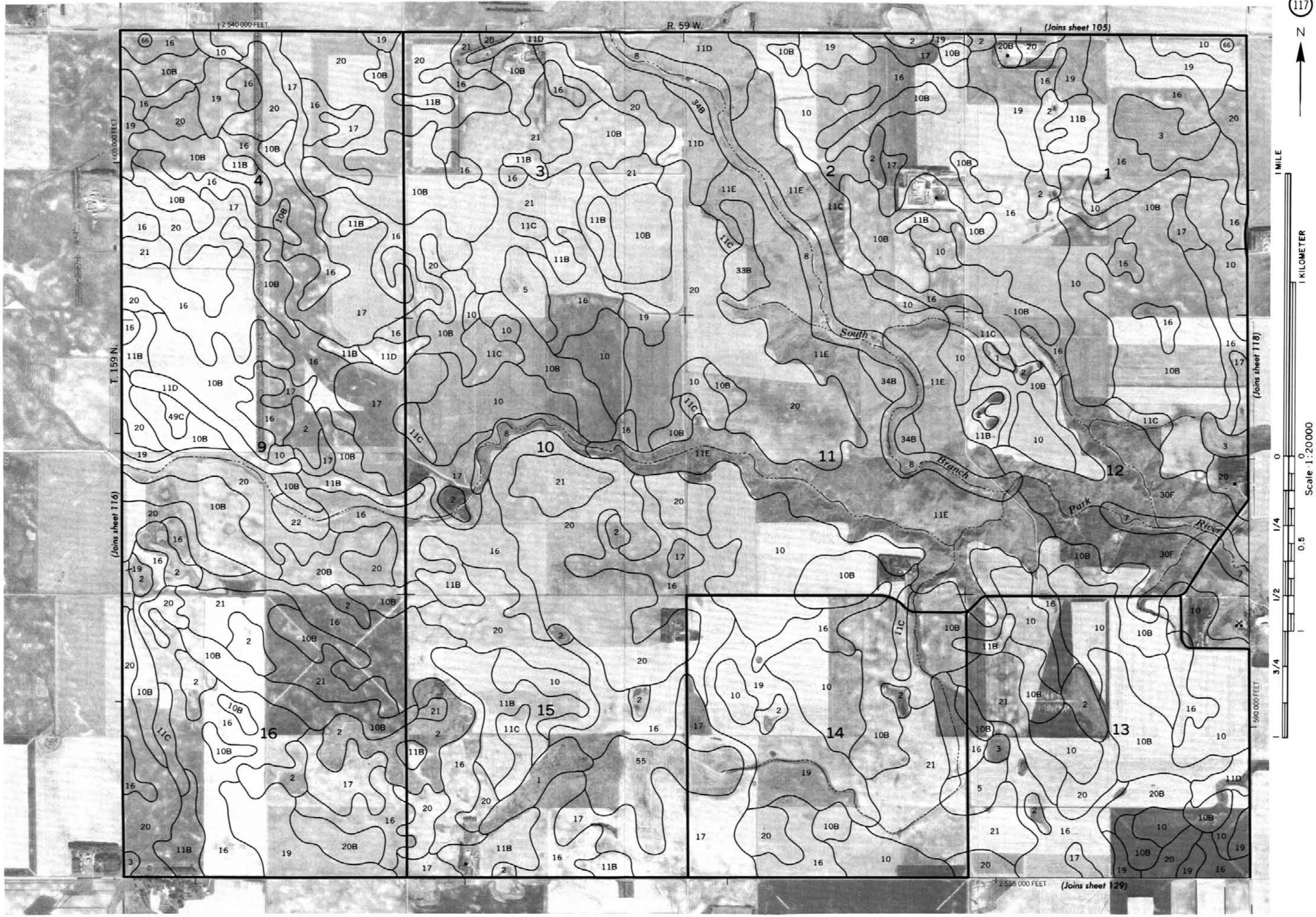

N
(Joins sheet 102)
R. 61 W.
2 495 000 FEET
600 000 FEET
T. 159 N.
(Joins sheet 115)
(Joins sheet 113)
(Joins sheet 126)
2 480 000 FEET
585 000 FEET
LOMA CEMETERY
LAKE NATIONAL WILDLIFE REFUGE
BILLINGS
Billings Lake
Coulee
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

115

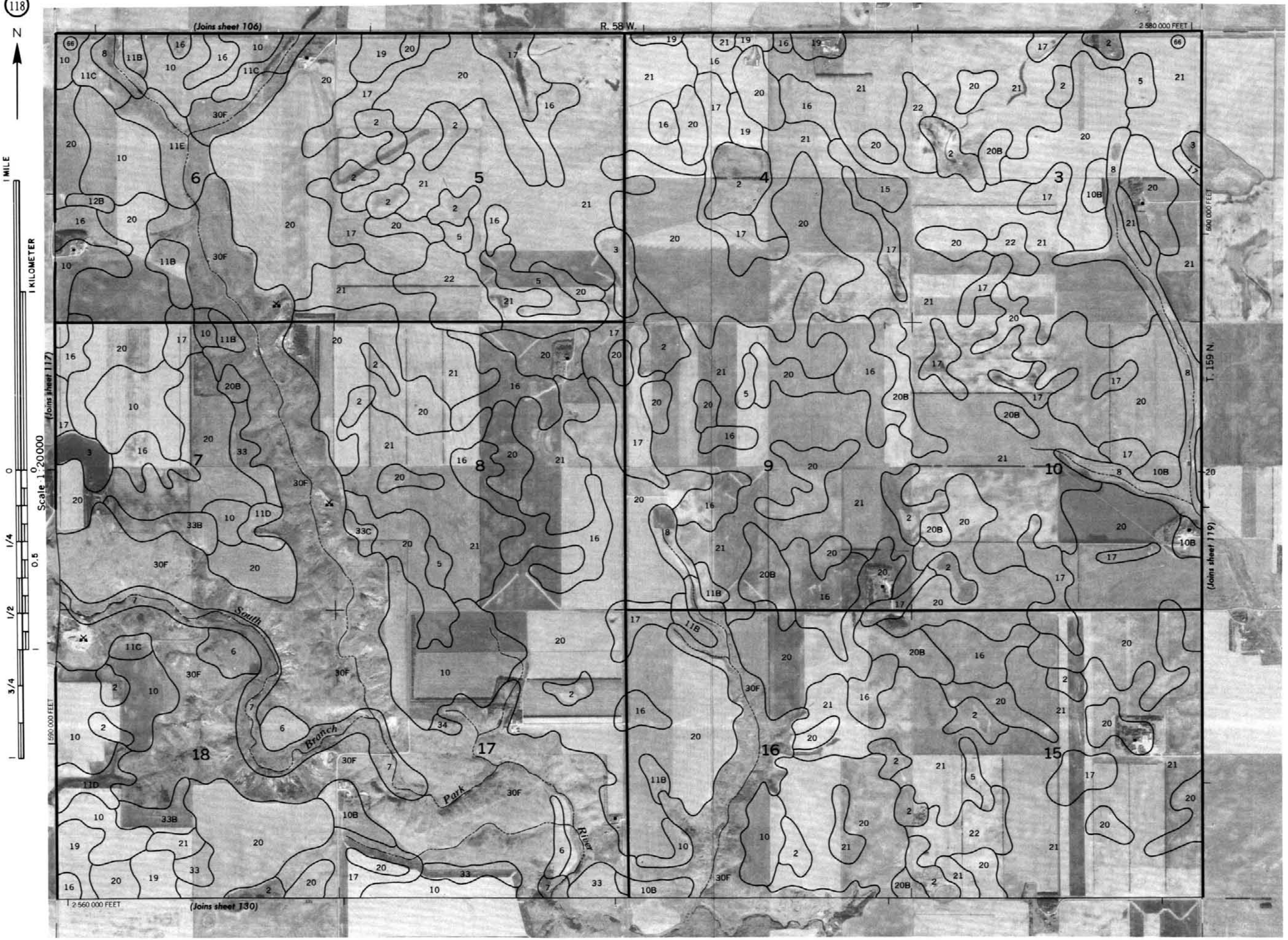

(Joins sheet 103)
R. 60 W.
2 500 000 FEET
600 000 FEET
T. 159 N.
(Joins sheet 114)
(Joins sheet 116)
(Joins sheet 127)
590 000 FEET
2 515 000 FEET
LINE
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
1


116
N
(Joins sheet 104)
R. 60 W.
R. 59 W.
2 535 000 FEET
600 000 FEET
T. 159 N.
(Joins sheet 117)
(Joins sheet 115)
590 000 FEET
LAGOON
2 520 000 FEET
(Joins sheet 128)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

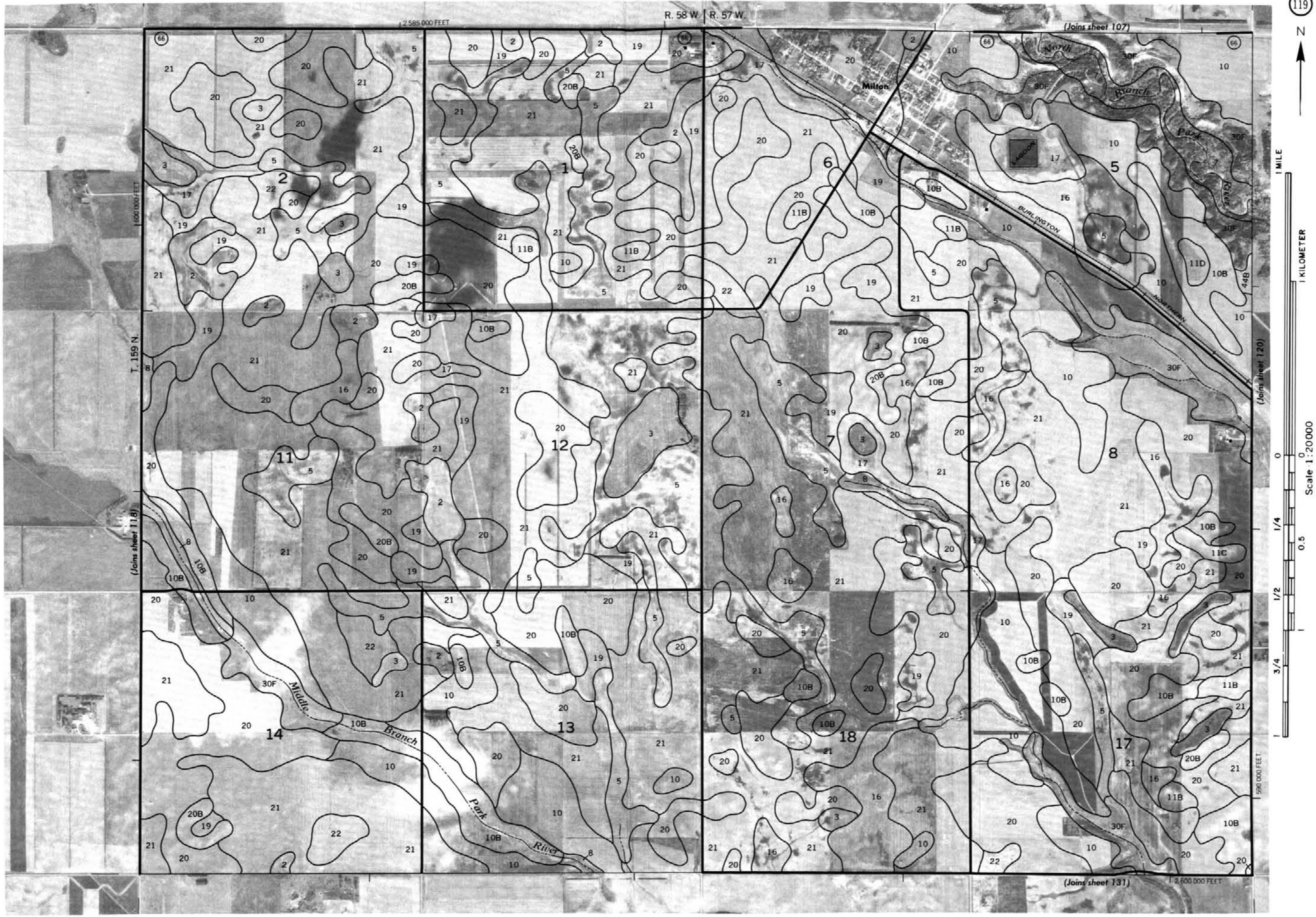
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 117

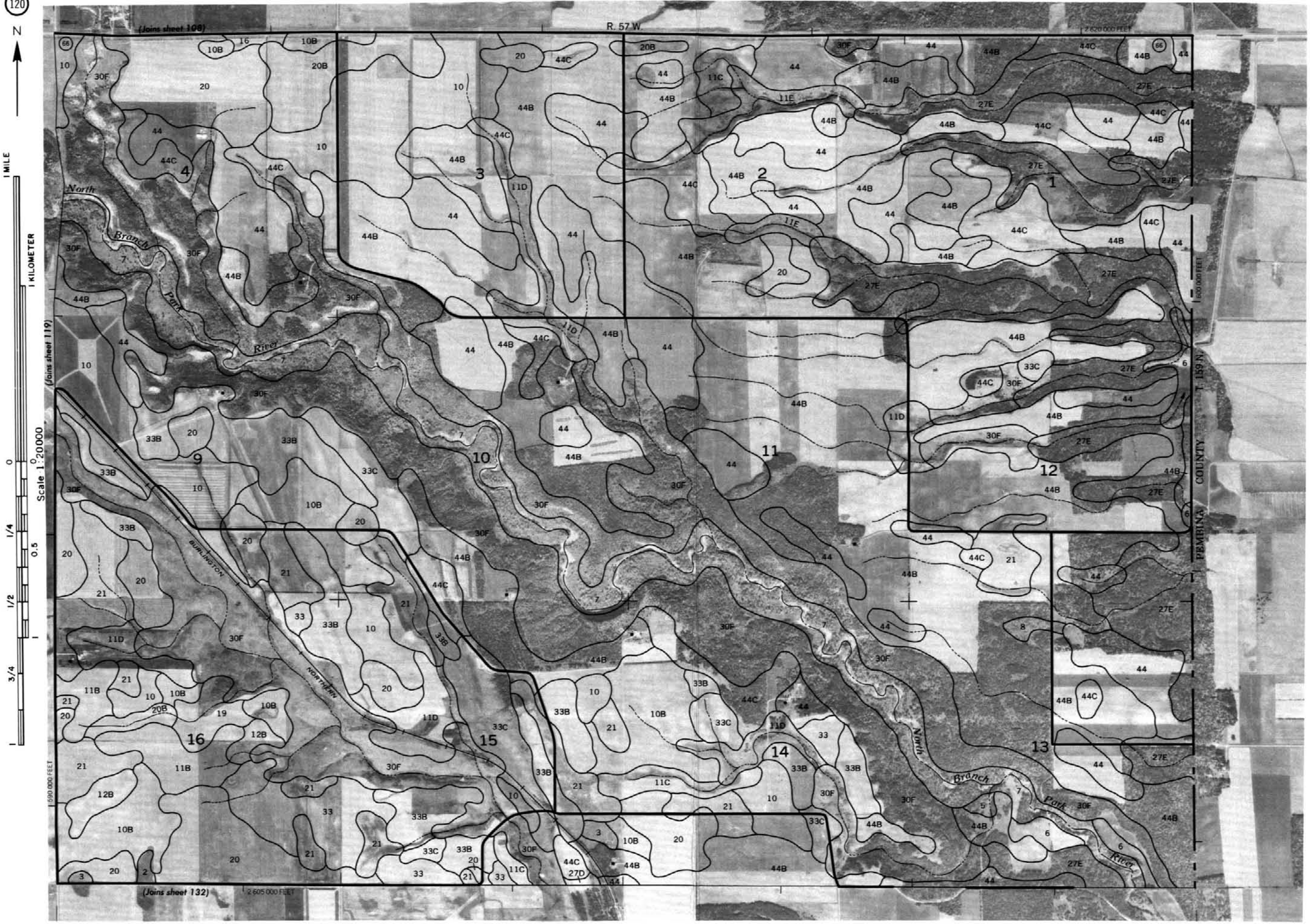


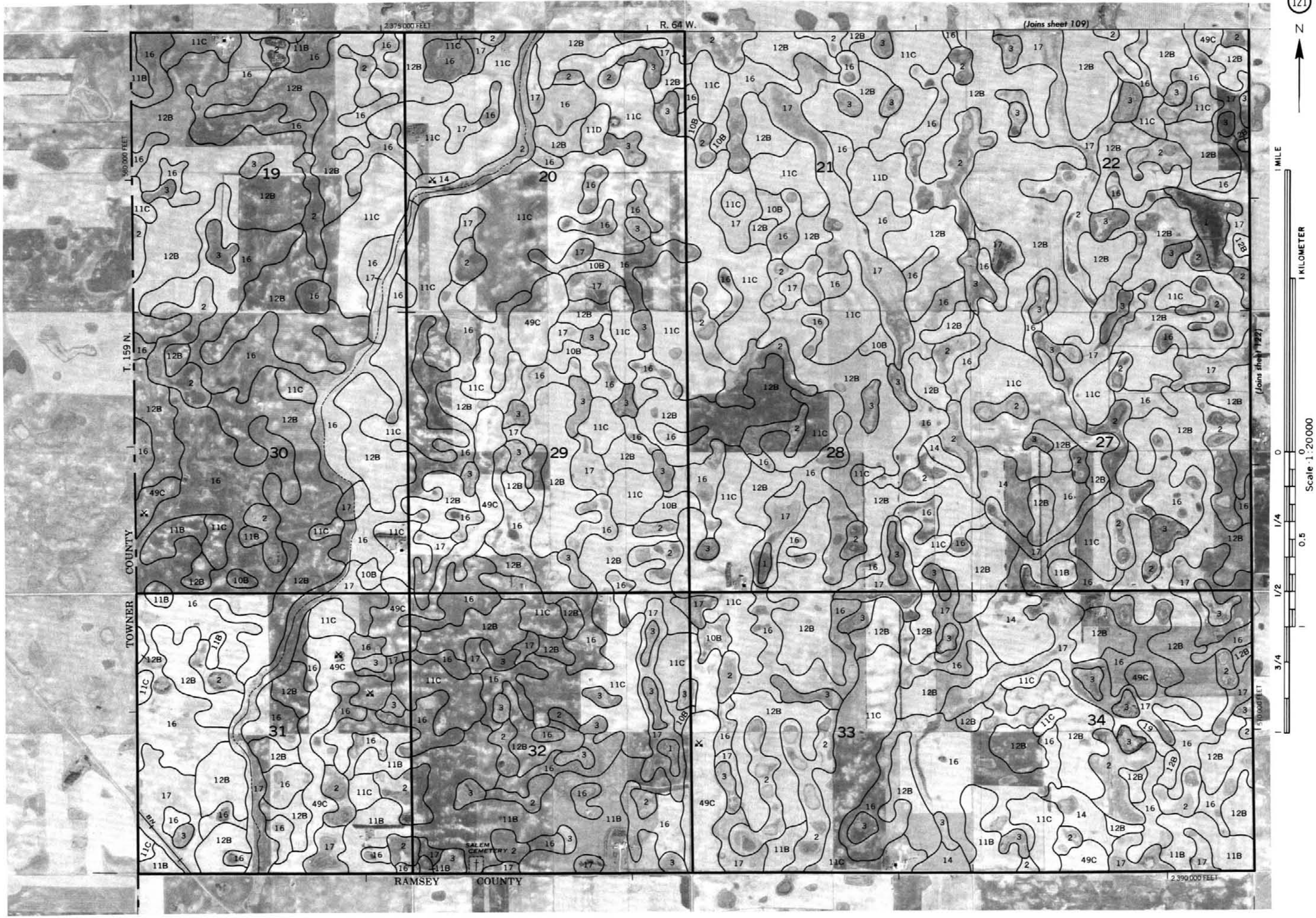
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 118

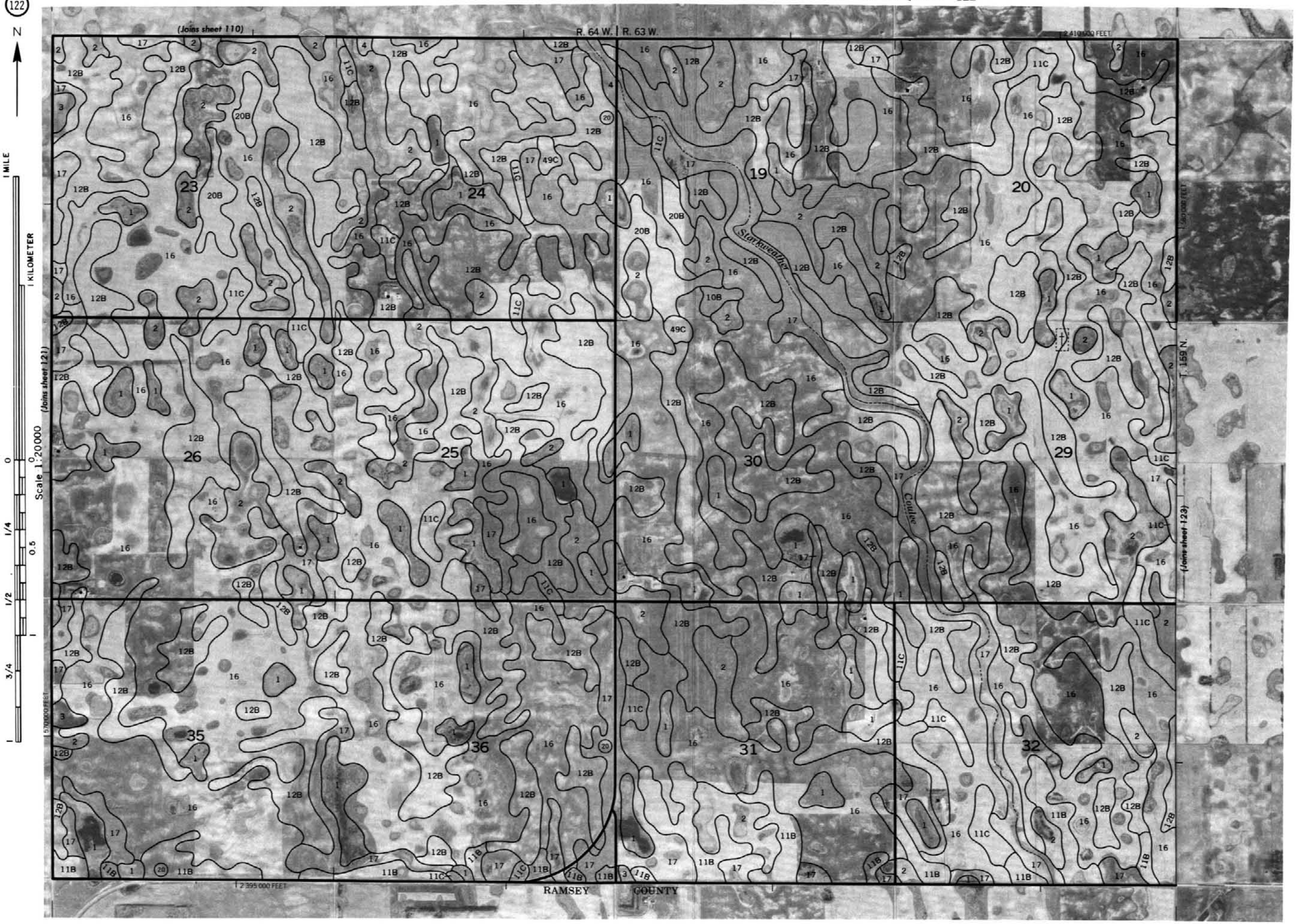


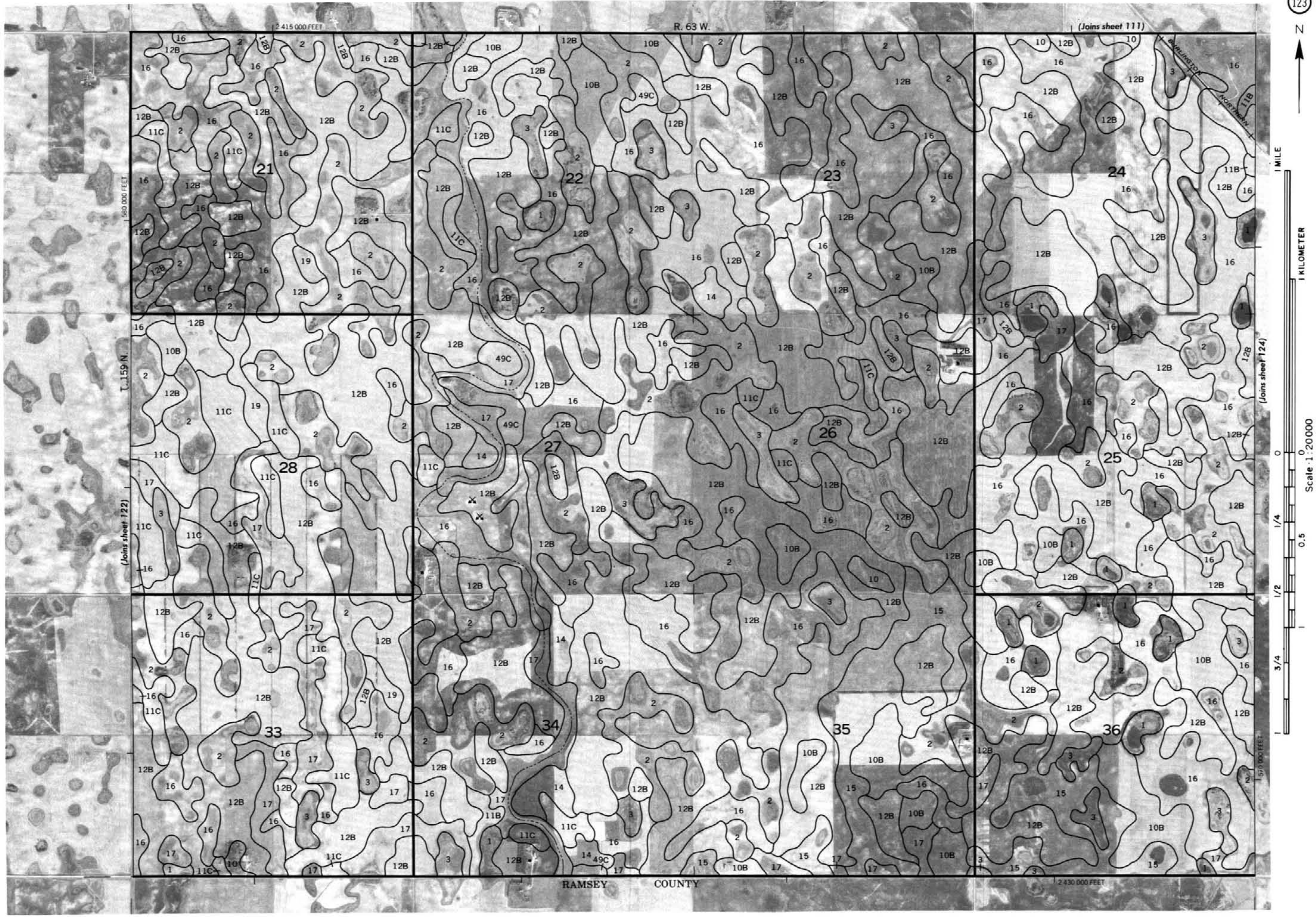
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 119




N
(Joins sheet 108)
R. 57 W.
2 620 000 FEET
(Joins sheet 119)
(Joins sheet 132)
2 605 000 FEET
590 000 FEET
600 000 FEET
North Branch Park River
BURLINGTON NORTHERN
PEMBINA COUNTY
T. 159 N.
1 MILE
1 KILOMETER
Scale 1:20000


R. 64 W.
(Joins sheet 109)
(Joins sheet 122)
T. 159 N.
TOWNER COUNTY
RAMSEY COUNTY
SALEM CEMETERY
2 375 000 FEET
2 390 000 FEET
560 000 FEET
19
20
21
22
30
29
28
27
31
32
33
34
N
1 MILE
1 KILOMETER
Scale 1:20000


122
N
(Joins sheet 110)
R. 64 W.
R. 63 W.
(Joins sheet 121)
(Joins sheet 123)
T. 159 N.
Starkweather
Coulee
RAMSEY
COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
2 410 000 FEET
2 395 000 FEET
570 000 FEET
23
24
19
20
26
25
30
29
35
36
31
32


2 415 000 FEET
R. 63 W.
(Joins sheet 111)
N
580 000 FEET
T. 159 N.
(Joins sheet 122)
(Joins sheet 124)
21
22
23
24
25
26
27
28
33
34
35
36
BURLINGTON NORTHERN
RAMSEY COUNTY
2 430 000 FEET
570 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 124

N

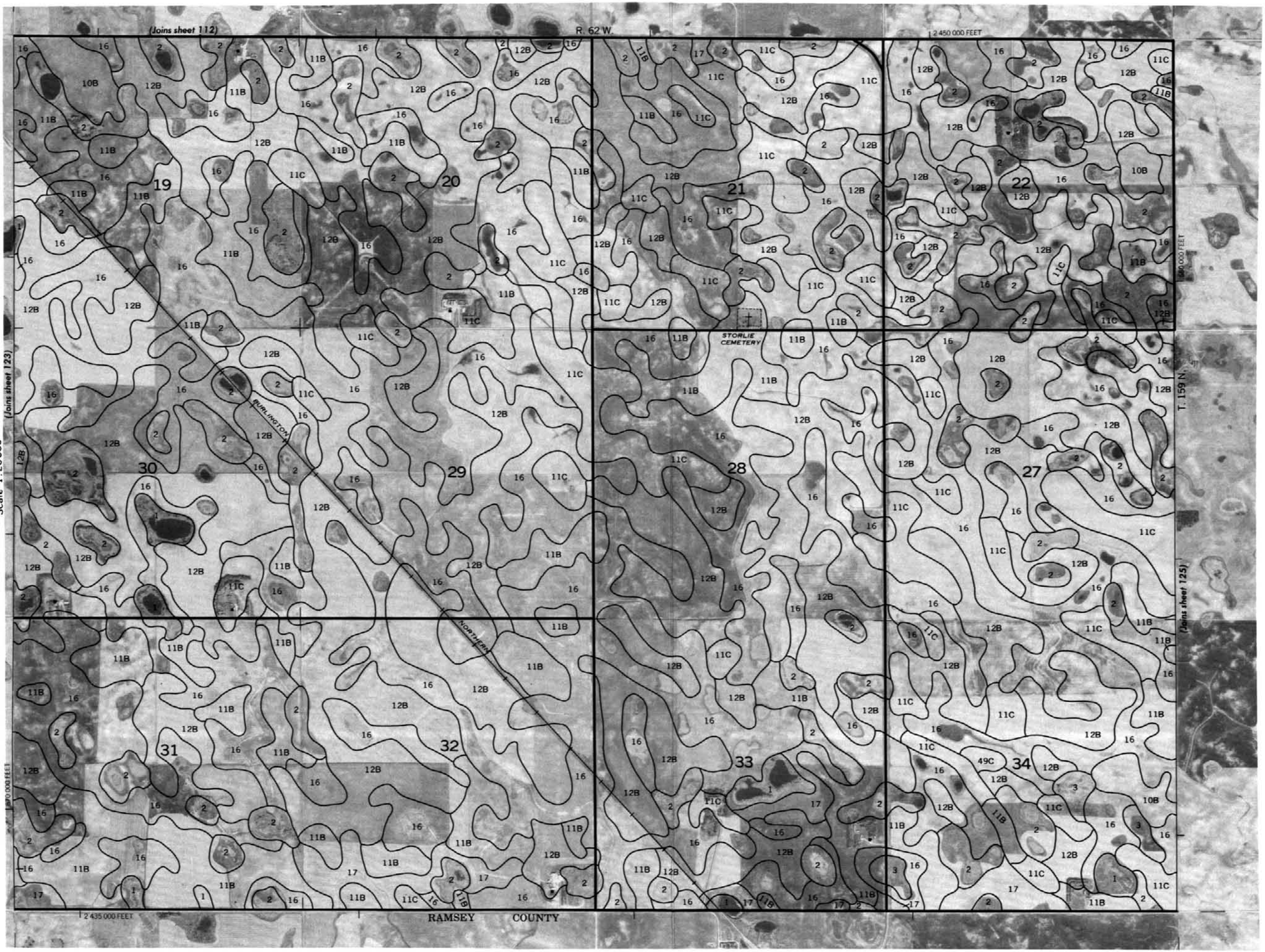
1 MILE

1 KILOMETER

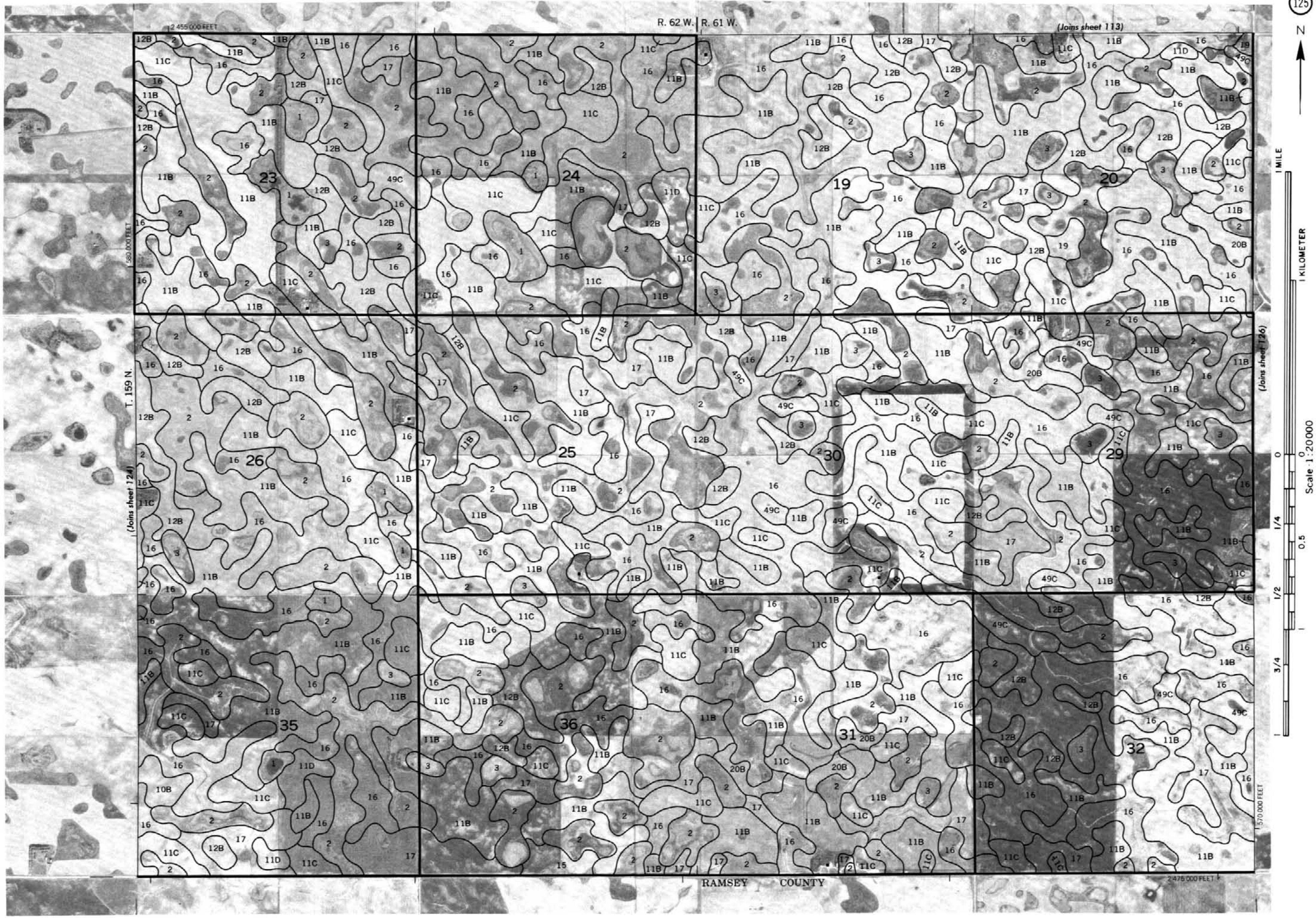
Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

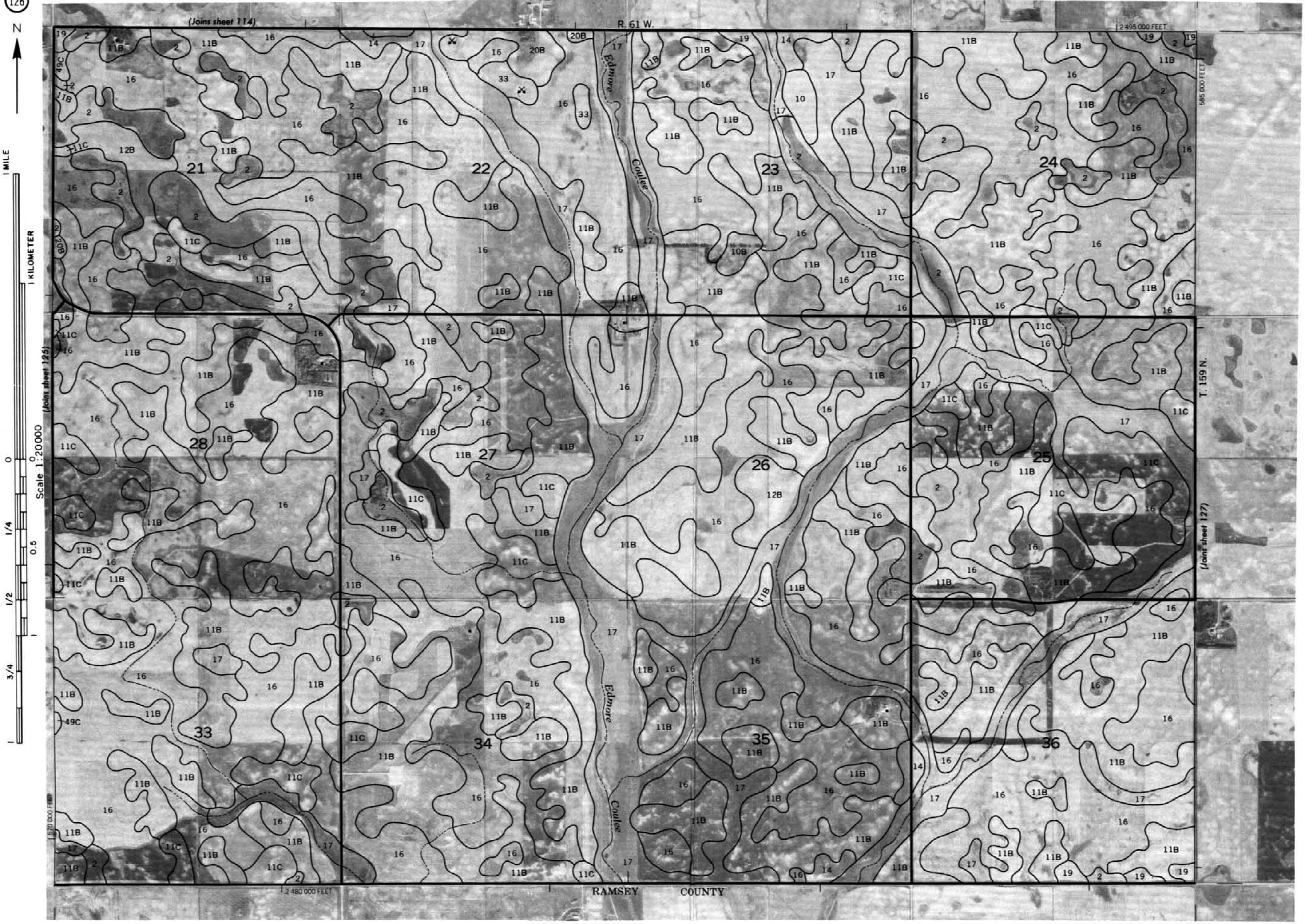


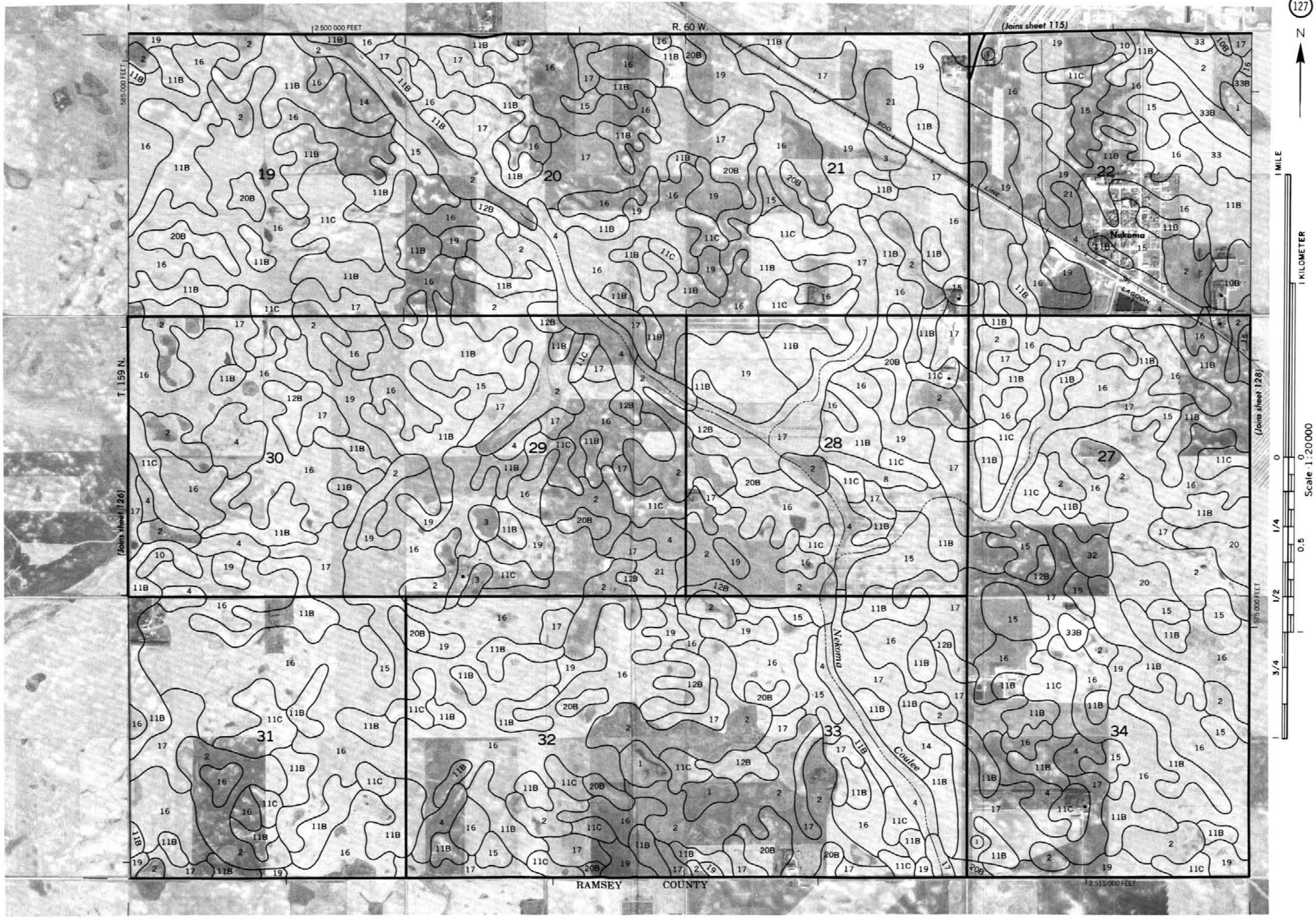
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 125



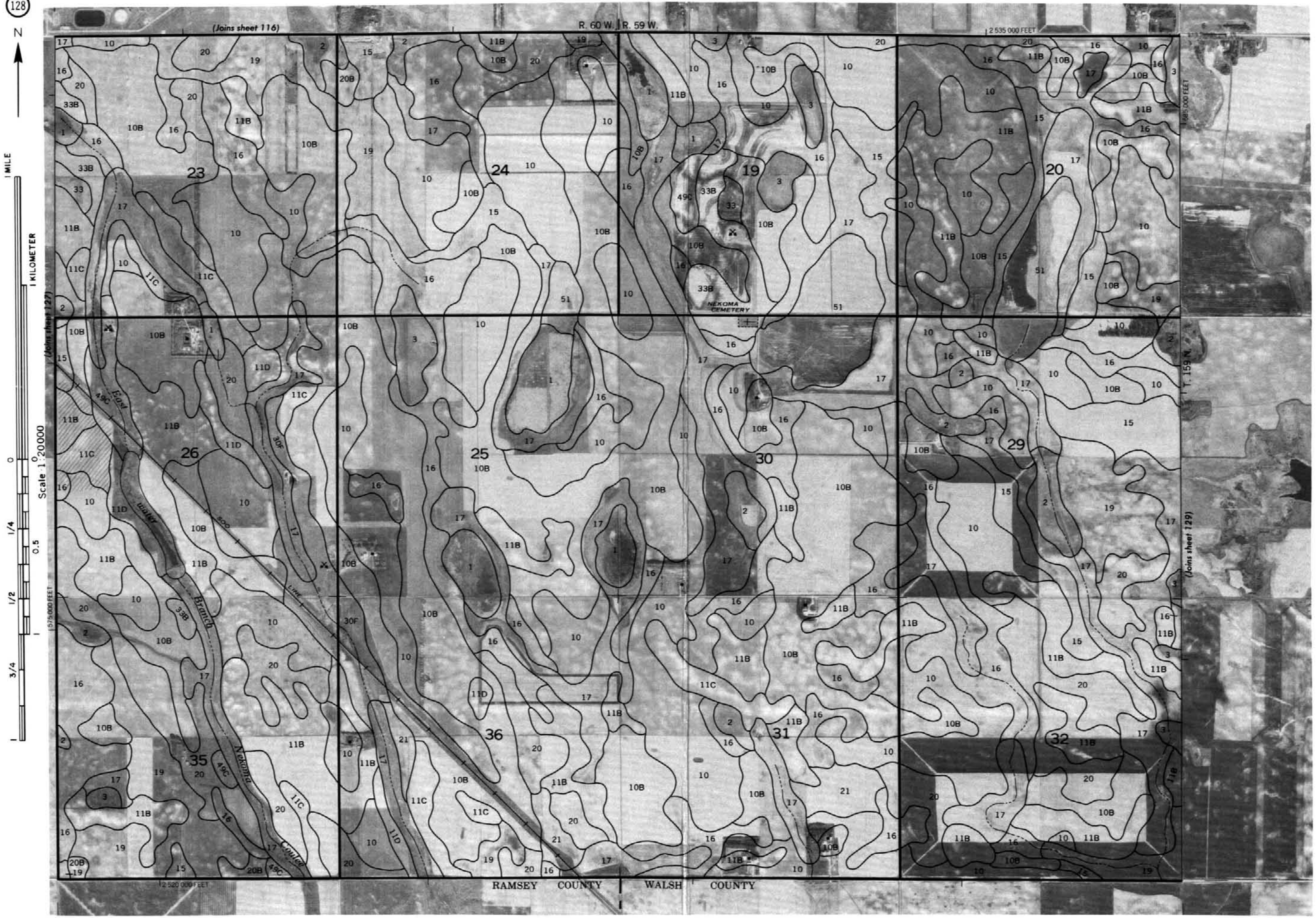
126

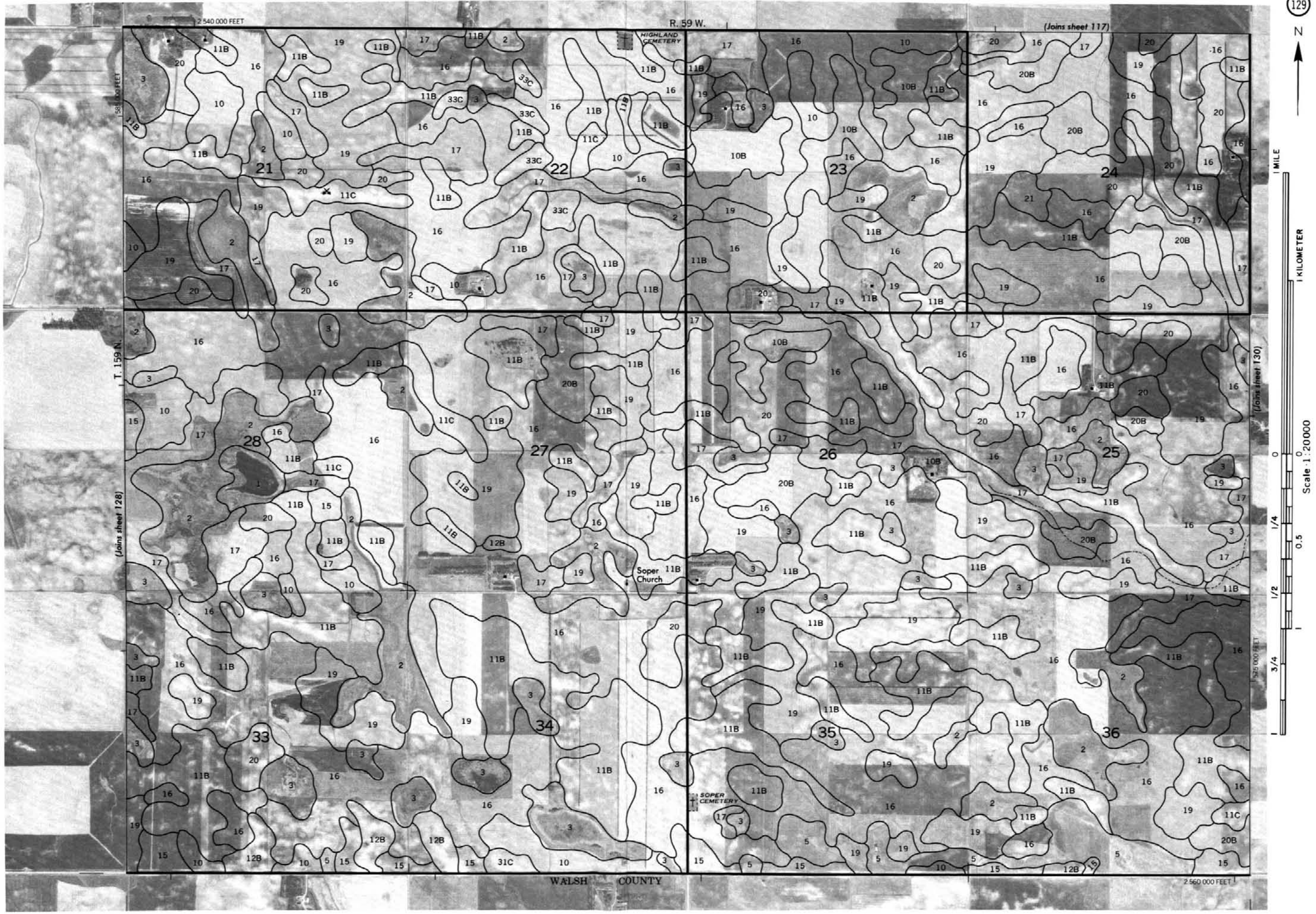
SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 126

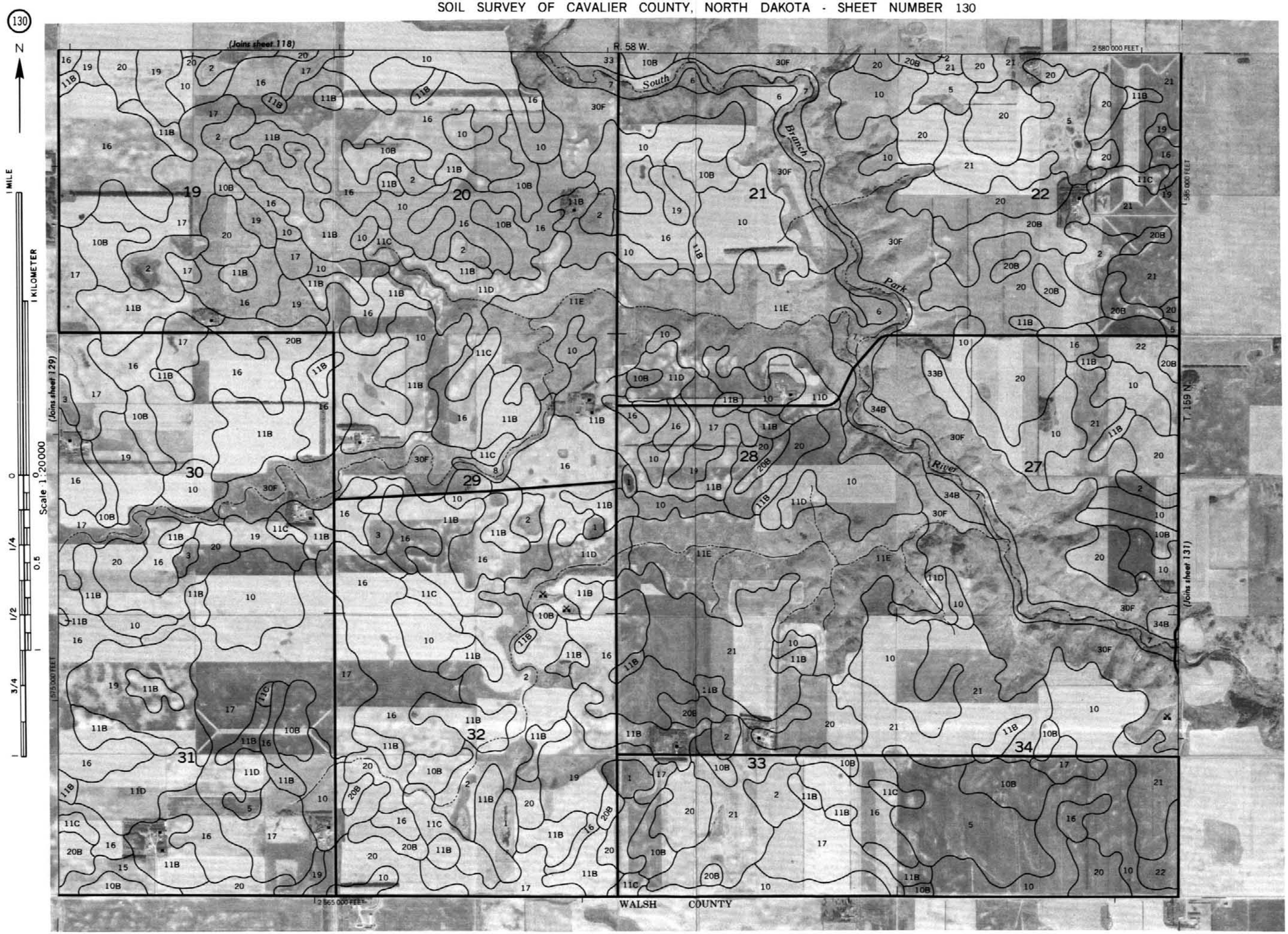


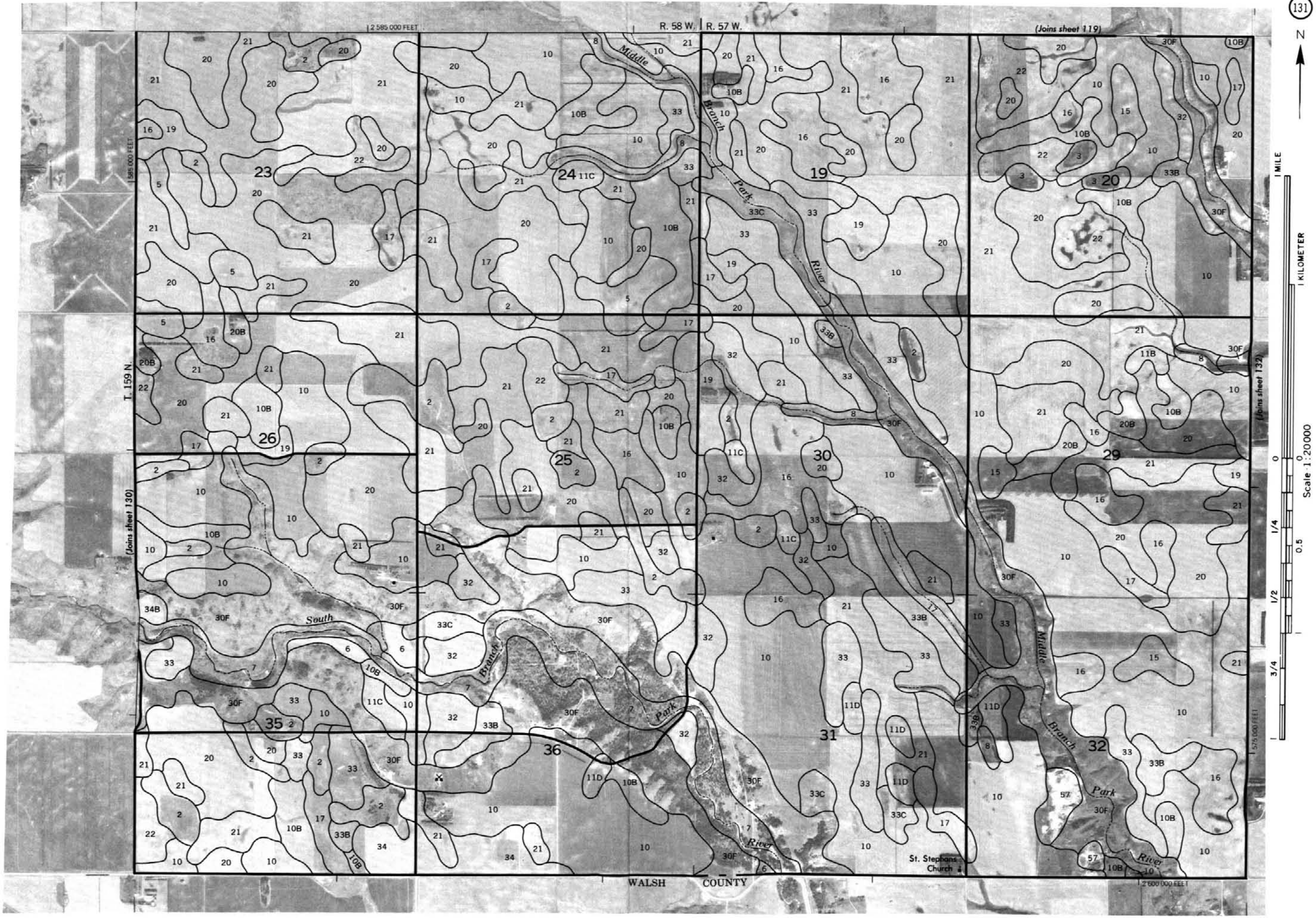

127
N
2 500 000 FEET
R. 60 W.
(Joins sheet 115)
585 000 FEET
T. 159 N.
(Joins sheet 126)
(Joins sheet 128)
SOO LINE
Nekoma
LAGOON
Nekoma Coulee
19
20
21
22
27
28
29
30
31
32
33
34
575 000 FEET
2 515 000 FEET
RAMSEY COUNTY
1 MILE
1 KILOMETER
Scale 1:20000

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 128




129
N
R. 59 W.
T. 159 N.
2 540 000 FEET
2 560 000 FEET
580 000 FEET
525 000 FEET
(Joins sheet 117)
(Joins sheet 130)
(Joins sheet 128)
HIGHLAND CEMETERY
Soper Church
SOPER CEMETERY
WALSH COUNTY
21
22
23
24
28
27
26
25
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


130
N
(Joins sheet 118)
R. 58 W.
2 580 000 FEET
South Branch
Park River
T. 159 N.
585 000 FEET
(Joins sheet 129)
(Joins sheet 131)
575 000 FEET
2 565 000 FEET
WALSH COUNTY
19
20
21
22
27
28
29
30
31
32
33
34
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


131
N
R. 58 W.
R. 57 W.
(Joins sheet 119)
(Joins sheet 132)
(Joins sheet 130)
T. 159 N.
2 585 000 FEET
2 600 000 FEET
575 000 FEET
Middle Branch Park River
South Branch Park River
WALSH COUNTY
St. Stephens Church
1 MILE
1 KILOMETER
Scale 1:20000

SOIL SURVEY OF CAVALIER COUNTY, NORTH DAKOTA - SHEET NUMBER 132